

DOCUMENT RESUME

ED 170 139

SE 027 599

AUTHOR Alsbrooks, Ann; And Others
TITLE Environmental Studies: A High School Course for Each Citizen, of Each Town, in South Carolina, U.S.A.
INSTITUTION South Carolina State Dept. of Education, Columbia.
PUB DATE 77
NOTE 772p.
EDRS PRICE MF05/PC31 Plus Postage.
DESCRIPTORS *Activity Units; Air Pollution Control; *Course Content; *Environmental Education; *Instructional Materials; Pollution; Science Activities; Science Education; *Secondary Education; Social Sciences; Water Pollution Control

ABSTRACT

This is a complete environmental studies course for high schools. It may be used as a year-long elective, a semester course, or infused by individual units into science, social studies, health, or other courses. The course is composed of thirteen separate units entitled: (1) Investigating Environmental Problems and Issues; (2) Energy; (3) Water; (4) Food and Fiber; (5) the Marsh Lands; (6) Ecosystems; (7) Land Use; (8) Climate and Air; (9) Population; (10) Wildlife; (11) Chemicals and You; (12) Solid Wastes; and (13) Noise. Each unit contains a short introduction, content statements, student objectives, student activities, and lists of resources. The activities are geared to the state, national, and global level, but there is an emphasis on issues and concerns of South Carolina.
(BB)

* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *

ED170139

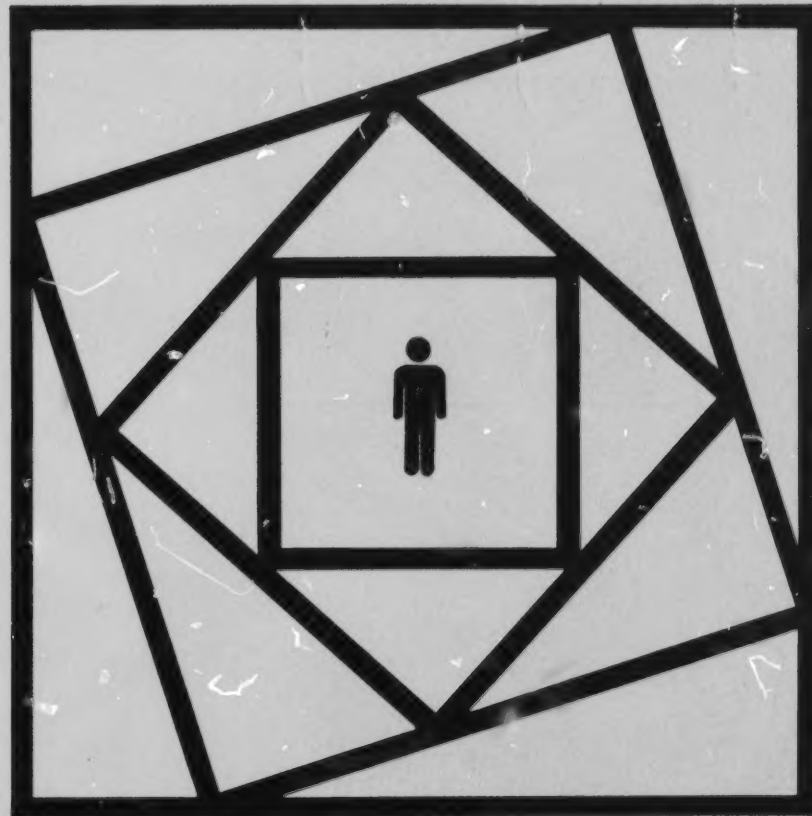
U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY.

"PERMISSION TO REPRODUCE THIS
MATERIAL HAS BEEN GRANTED BY

Elmer L. Knight

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC) AND
USERS OF THE ERIC SYSTEM."



Environmental Studies

a high school course
FOR EACH CITIZEN, OF EACH TOWN, IN SOUTH CAROLINA, U. S. A.

SE 087 599

22

South Carolina Department of Education, Charlie G. Williams, State Superintendent

3

ENVIRONMENTAL STUDIES

Developed by

South Carolina Department of Education

Alice Linder, Consultant
Environmental Education

Beverly Enwall, Chief Supervisor
Curriculum Development Section

Henry G. Hollingsworth, Director
Office of General Education

Charlie G. Williams, State Superintendent
South Carolina Department of Education

ACKNOWLEDGEMENTS

This course of study represents the efforts of the South Carolina Department of Education to respond to the requests of the school districts for a high school elective in ENVIRONMENTAL STUDIES. It would not have been possible without the help and cooperation of many individuals, organizations and agencies.

Ten concerned and dedicated teachers spent two weeks in the summer of 1977 writing the preliminary materials. The product generated from these sessions was well received by the many teachers who piloted the course. Grateful acknowledgement is extended to these individuals for their invaluable contribution.

Mrs. Ann Alsbrooks
St. Andrews Senior High School
Charleston, SC

Mrs. Mary Crum
Denmark-Olar High School
Denmark, SC

Mrs. Barbara Evans
Brookland Cayce High School
Cayce, SC

Mrs. Paula Fitzpatrick
Airport High School
West Columbia, SC

Mrs. Polly Goldston
Aiken, SC

Mrs. Willie J. Lanham
Aiken High School
Aiken, SC

Mrs. Maxine H. Moore
Spartanburg Senior High School
Spartanburg, SC

Mr. Venning Morrison
Airport High School
West Columbia, SC

Mrs. Polly Powell
Aynor High School
Aynor, SC

Mrs. Sara Lee Simons
St. Johns High School
Darlington, SC

Sincere appreciation is also extended to the many State agencies and organizations who sent personnel to assist the writing committee. Their advice, materials and technical assistance were extremely valuable and useful.

Gratitude is also extended to the committee who rewrote and developed the final product and to the teachers who assisted through critiques of the materials. Special recognition goes to those three individuals who gave freely of their time and energy in the editing of the final version.

Mrs. Barbara Evans, West Columbia
Mrs. Maxine H. Moore, Spartanburg
Mrs. Doris Platt, Chester High School, Chester

Appreciation is also extended to the secretaries of the Curriculum Section for their generous assistance and to the Production Section of the Education Products Center for their willing cooperation in this endeavor. Special recognition goes to Miss Marie Carter who typed and prepared the final copy.

A MESSAGE TO THE TEACHER

During the past few years, public awareness and concern about the environment have increased dramatically. Our democracy depends on citizen participation and legislation now requires it for necessary decisions concerning the environment. Therefore, the schools have a responsibility to educate students in environmental studies.

The "back to the basics" movement is beginning to place emphasis on essential learning skills as well as reading and math. These skills include training in problem solving, decision making and knowledge that will help students cope with the changing environment and maintain a suitable quality of life.

Environmental awareness, responsible citizenship and essential learning skills may be a part of the subjects of science, social studies and health. However, a prepared course with this content has not been available to our teachers. For this reason ten teachers came together in Columbia in the summer of 1977 to write units for such a course. These units were piloted during the following school year and then in the summer of 1978 were rewritten, based on critiques from teachers. The course is for teachers and by teachers at the high school level. The course was designed to be easily adaptable to:

- different levels of ability
- varied background of teachers
- different subject areas.

It may be used as a year long elective, a semester course, a quinmester course, or infused by individual unit into science, social studies or health and possibly other areas. Only the unit on ecosystems is predominantly science oriented.

The course is a compilation of thirteen separate and complete units of study which are timely, challenging and inexpensive. They cover basic human concerns on local, state, national, and global levels, but with an emphasis on South Carolina's own unique issues and concerns.

This is a total program but if you wish text reference books for students, some suggestions are listed on the following page. No text is required but several different ones may be most useful. This publication has been designed so that you may use it as a single book or you may take it apart by units and arrange it to meet your own personal needs. Each unit could be placed in a separate binder. We hope that you will enjoy teaching this course.

THE WRITING COMMITTEE

RECOMMENDED STUDENT TEXTS

Andrews, Wm. A. et.al. Contours: Studies of the Environment. Englewood Cliffs, N.J.: Prentice Hall, Inc. 1972. This is a set of four paperbacks averaging about 250 pages each: Environmental Pollution, Freshwater Ecology, Soil Ecology, Terrestrial Ecology.

Breeden, Robert L., Chief, Special Publications Division, National Geographic Society. As We Live and Breathe. National Geographic Society, Washington, D.C. 20036. This is a 240 page hardback with good photography and color pictures but small print. It may be more useful as a reference rather than a text.

Foster, Phillips W. and Roger H. Hermanson. Programmed Learning Aid for Introduction to Environmental Science. Homewood, Ill. 60430, Learning Systems Co., 1972, a 181-page paperback.

Gregory, George Peter. Environmental Concerns - The Nation. Atlanta, GA: Harcourt Brace Javanovich, Inc. 1977. This is a 122 page paperback with teachers guide. Includes many case studies.

McCombs, Lawrence and Nicholas Rosa. What's Ecology? Menlo Park, CA: Addison-Wesley Publishing Co. 1973. This is a 250 page paperback largely limited to ecosystems. It has a teachers guide.

O'Donnell, Patrick A. et.al. Environmental Studies Series. Menlo Park, CA: Addison-Wesley Publishing Co. Inc., 1971. A set of paperbacks averaging 94 pages each: Water Pollution, Air Pollution, Noise Pollution.

Wang, J.Y. et.al. Exploring Man's Environment. Atlanta, GA: Field Educational Publications, Inc. 1973. This is a 376 page paperback with questions and activities for each chapter.

RECOMMENDED REFERENCES FOR THE TEACHER

McCabe, Robert H. and R.F. Mines. Man and Environment. Englewood Cliffs, N.J.: Prentice Hall, Inc., Vol 2, National Association for Environmental Education, 5940 S.W. 73rd St., Miami, Fla. 33143, 1973. A 91 page paperback consisting of 20 modules each composed of basic concepts and student objectives.

Miller, G. Tyler, Jr. Living in the Environment: Concepts, Problems, and Alternatives. Belmont, CA: Wadsworth Publishing Co. Inc., 94002, 1975. This is a college freshman course, about 500 page hardback, most comprehensive reference for teachers. Could be used with gifted or advanced classes.

Pavoni, Hagerty and Heer. Preserving Man's Environment. Louisville, Kentucky: Data Courier, 620 S. 5th St., Louisville 40202. This is a 308 page hardback with tests on each topic and on the whole course. It includes a division of treatment for basic classes and for advanced classes, resources, activities.

TABLE OF CONTENTS

INVESTIGATING ENVIRONMENTAL PROBLEMS AND ISSUES	1
ENERGY	7
WATER	55
FOOD AND FIBER	105
THE MARSH LANDS	145
ECOSYSTEMS	185
LAND USE	205
CLIMATE AND AIR	243
POPULATION	283
WILDLIFE	309
CHEMICALS AND YOU	349
SOLID WASTES	367
NOISE	385

INTRODUCTION

BACK TO THE BASICS

"Back to the basics" is the clarion call of the people to educators in the 1970's.

What really are the basics?

What could you NOT live without?

Water to drink
Air to breathe
Food to sustain the body and provide energy
Shelter to protect
Space to carry out life's functions
Energy and material goods to maintain life

To obtain these basics and the not-so-basics, you must have an income, dollars to trade for what you want to improve the quality of life.

The majority of citizens in the United States consider a high quality of life "basic". To obtain this quality of life, the economy has high priority, resource use is extensive, waste is tremendous, and conflicts of values appear at every turn. At the same time, the majority of people in the world are struggling to obtain the basics - water, air, food, shelter, space, energy, and material goods.

How you live, how you wisely use or destroy, is your decision.

How do you decide?

Where do you find valid information?

How do you weigh alternatives and their consequences?

How do you maintain "the good life" without destroying "the basics"?

This is the content of ENVIRONMENTAL STUDIES.

Alice Linder, Consultant
Environmental Education

INVESTIGATING ENVIRONMENTAL PROBLEMS AND ISSUES

An Environmental Studies Course encompasses the basic concerns of all humans and develops skills to deal with them effectively.

CONTENT	STUDENT OBJECTIVES	STUDENT ACTIVITIES	RESOURCES
Whether on a local, national or international level, people are constantly faced with many conflicting ideas. One must make decisions about his actions on a societal level. Classroom activities which develop problem solving and decision making skills can have an important impact on citizen participation in a democratic society. Possible South Carolina concerns for study include: 1. Cooper River rediversion 2. Port Royal expansion 3. Congaree flood plain park 4. Nuclear waste 5. Recycling 6. Tidelands 7. Russell Dam 8. Population explosion on the coast 9. Energy (auto emissions controls, etc) 10. NPDES Permit Program (National Pollutant Discharge Elimination System)	Student will be able to: 1. Recognize and identify the problem 2. Identify and collect data from as many different sources as possible 3. Objectively analyze and interpret data collected 4. List all possible alternatives for resolving the problem 5. Analyze each alternative for: a. short and long range consequences b. cost/benefit ratio 6. Decide on the best alternative (Don't forget to check present legislation on the issue) 7. Develop plan of action 8. Carry out appropriate action 9. Evaluate results 10. Follow up	Collect information of issues from newspaper, magazines, agencies, interviews and maps. Record and interpret the information. Students will role play to present one part of the problem through the eyes of one of the interest groups. Record all information from the presentations and written materials obtained. Present written recommendations for possible alternative resolutions with statements of justification. Prepare a summary of comparisons of alternatives and points of view. Identify activities which would be appropriate for their involvement. Write a written report on the results of the action taken and the evaluation of that action. Recommend follow-up activities.	See Page 2,3

BIBLIOGRAPHY

Environmental Action Foundation. The End of the Road: A Citizen's Guide to Transportation Problem Solving. Washington, D.C.: Environmental Action Foundation, 724 Dupont Circle Build. \$3.50.

EPA JOURNAL. The Environmental Protection Agency publishes a monthly journal which examines issues such as "Controlling Noise Pollution," "Keeping Your Drinking Water Safe," and "Why Our Wetlands Are Vanishing." Public Information Center (PM-215), U.S. Environmental Protection Agency, Washington, D.C. 20460.

Indiana Department of Public Instruction. "A Process for Investigating Environmental Issues," Whole Earth Design. Indianapolis, Indiana, 1976.

Joint Council on Economic Education. The Economics of the Energy Problem. New York, NY: Joint Council on Economic Education, 1212 Avenue of the Americas.

Joint Council on Economic Education. The Economics of Pollution. New York, NY: Joint Council on Economic Education, 1212 Avenue of the Americas.

Joint Council on Economic Education. The Economics of the Oceans. New York, NY: Joint Council on Economic Education, 1212 Avenue of the Americas.

Marlett, Robert. Current Issues in Environmental Education. Columbus, OH: The ERIC Center for Science, Mathematics, and Environmental Education, The Ohio State University, 1976. PP. 192.

McCabe, Robert H. Current Issues in Environmental Education III. Columbus, OH: The ERIC Center for Science, Mathematics, and Environmental Education, The Ohio State University, 1977. PP. 272.

New York State Education Department. An Environmental Syllabus: Grades 10, 11, 12. Albany, NY. Bureau of General Education Curriculum Development, 1976.

North, Douglas C., et. al. The Economics of Public Issues. Harper Row. 1971.

A wealth of information maybe obtained from each State resource agency. The following articles from the South Carolina Wildlife" magazine will also be helpful:

South Carolina Wildlife Issues

May-June 1973	The Salt Marsh and Estuaries
September-October 1976	Energy on a Budget
July-August 1976	Trotters Shoals: The Big Boondoggle
January-February 1976	The Nuclear Future
November-December 1974	Offshore Oil
November-December 1976	Toward Extinction The Packaging Boom
March-April 1977	Somebody's Watching Black Creek
July-August 1973	Congaree Swamp Population
March-April 1975	Salt Marsh: A Question of Survival
November-December 1975	Which Way Carolina Alien Animals
January-February 1973	Our Land: Changes and Challenges

A SAMPLE ACTIVITY

(Source - New York Dept. of Education, An Environmental Syllabus)

1. Provide the students with the following list of concerns faced by the people of our Nation, or have students suggest items for such a list.
Ask them to briefly study the 18 problems and then number them in rank order from the most serious (1) to the least serious (18).

Communism
Crime
Drugs
Economy
Education
Energy Shortage

Foreign Policy
Health Care
Housing
Integrity in Government
The Aged and Aging
Overpopulation

Pollution
Racial Discrimination
Taxes
War
Welfare Reform
Women's Rights

2. Ask students to list reasons for the five most serious concerns cited.
3. Determine the consensus of the class regarding the 18 concerns and the five most serious concerns. Examine the reasons given to justify the five most serious concerns. Do they justify them?
4. How many of the 18 concerns are environmentally oriented? How many of the 5 most serious are environmentally related? Discuss.
5. Convert the results of the classroom poll to percentages. Are the results of this poll valid? Explain. How are Gallup or Harris polls conducted? Discuss.
6. Ask students to rank the following environmental issues from most serious (1) to least serious (12). Tally the results and discuss reasons for the rankings.

Chemical, Biological, and Radiological Contamination (pesticides, detergents, pests, radiation)
Consumerism (advertising, status products, poor information)
Economic/Social/Cultural Environments (lifestyles, housing, poverty, jobs)
Energy (reduced resources, excessive demands)
Health (pollution, drugs, stress, food additives)
Land Use (abuse, poor or no planning)
Natural Environments (loss of wildlife habitat, endangered species)
Pollution (air, water, noise, aesthetic)
Population (distribution, density, growth rate, food supply)
Resources (depletion of nonrenewable resources, loss of renewable resources and lack of recycling)
Solid Waste (hazardous and costly disposal methods, lack of recycling)
Transportation (cost in energy, need for mobility, safety)

7. Determine the presence of a consensus among class members concerning the 12 environmental issues.
 8. Identify and describe any interrelationships between the 12 issues.
 9. Convert the class results to percentages and discuss the reliability of the results.
 10. Conduct a similar poll in other classes in school, tally results and prepare a summary statement.
-
-

SAMPLE ACTIVITY

Use the chart on the next page as an introduction to the concept of environmental impact. The suggested projects listed across the top of the chart will give students an idea of the range of human activity which affects the environment which is represented by the areas of potential impact listed in the left-hand column.

Ask students to fill in the chart using the symbols in the key below:

- + = a beneficial effect anticipated for the environmental factor
- = an adverse effect anticipated
- 0 = no appreciable change anticipated

Once decisions have been made for every impact feature in a project column, a simple comparison of + and - responses will suggest whether or not the project seems feasible. Students may wish to qualify some of their decisions and should be encouraged to do so on an additional piece of paper.

FOLLOW UP ACTIVITY

Have each student compose an "environmental ethic" after a brief review of the 12 environmental concerns or state concerns previously discussed. The statement should consist of:

- the students' personal assessment of the status of these concerns today in our nation.
- differentiation between a right and a responsibility.
- listing of at least five "environmental rights."
- listing of at least five "environmental responsibilities."
- personal assessment of the worth or value of the natural environment.
- indication of the importance of our modern, technological way of life.
- prediction of the eventual solution to the environmental predicament.

Save these statements of environmental ethic and compare with statements written at the end of the course.

Project Impact → ↓	A. Sewage Treatment Plant	B. Highway Construction	C. Apartment Complex	D. Shopping Center	E. Nuclear Power Plant	F. Zoning Change: Commercial to Agricultural	G. Airport Expansion
1. Air Quality							
2. Water Quality							
3. Noise							
4. Natural Habitats							
5. Minerals							
6. Solid Waste							
7. Contaminants (radioactive; chemical, etc.)							
8. Water Table							
9. Topography							
10. Aesthetic Quality							
11. Transporta- tion							
12. Scenic Areas							
13. Economic Condition							
14. Population Density							
15. "Quality of Life"							

THE ENERGY PROBLEM

The earth's fossil fuel reserves are finite and rapidly shrinking. The United States uses 33% of the yearly energy supply with only approximately 7% of the world's population. The living standard of the rest of the world is rapidly rising and they are demanding a greater share of these resources.

National and individual conservation measures must be initiated, and policies controlling research into new energy supplies must be carefully determined and actively pursued.

Recommended text for Energy Unit:

Energy and Society - Investigations in Decision Making. BSCS, published
by Hubbard Company, Northbrook, Illinois 60062.

CONTENT

Introduction: Information in
"Test Your Energy IQ."

The historical development of
energy consumption shows exponen-
tial growth in energy use.

STUDENT OBJECTIVES

The student will be able to:

Evaluate his knowledge of
energy use and abuse.

Identify and define major
energy terms.

Compare the use of energy
today with that prior to the
Industrial Revolution.

Develop skills in graph
interpretation.

STUDENT ACTIVITIES

Complete energy IQ test.

View films or filmstrips:
"When the Circuit Breaks;"
"Using Energy;"
"Energy: Critical Choices
Ahead."

Compile a glossary of energy
terms as you view films and read
articles related to the energy
problem.

View The Great Search and dis-
cuss: your general reaction;
the energy impact on history.

Using the chart, U. S. Energy
Consumption 1850-1974, answer
the following questions:

- ...What were the sources of
energy prior to the Civil
War?
- ...What was the total annual
energy consumption at the end
of the Civil War?
- ...Find out the population at the
end of the Civil War and use
it to figure the annual per
capita consumption at that
time.
- ...In what year did oil consump-
tion exceed coal consumption?

RESOURCES

Test Your Energy IQ from
S. C. Energy Management
Office, see page 37-40

Films and filmstrips from
Energy Management Office
or S. C. Department of
Education.

Graph page 10.

Almanac

CONTENT

Energy consumption today reflects our standard of living and our increased population.

STUDENT OBJECTIVES

The student will be able to:

Assess the effects of the U. S. use of a disproportionate amount of the world's energy.

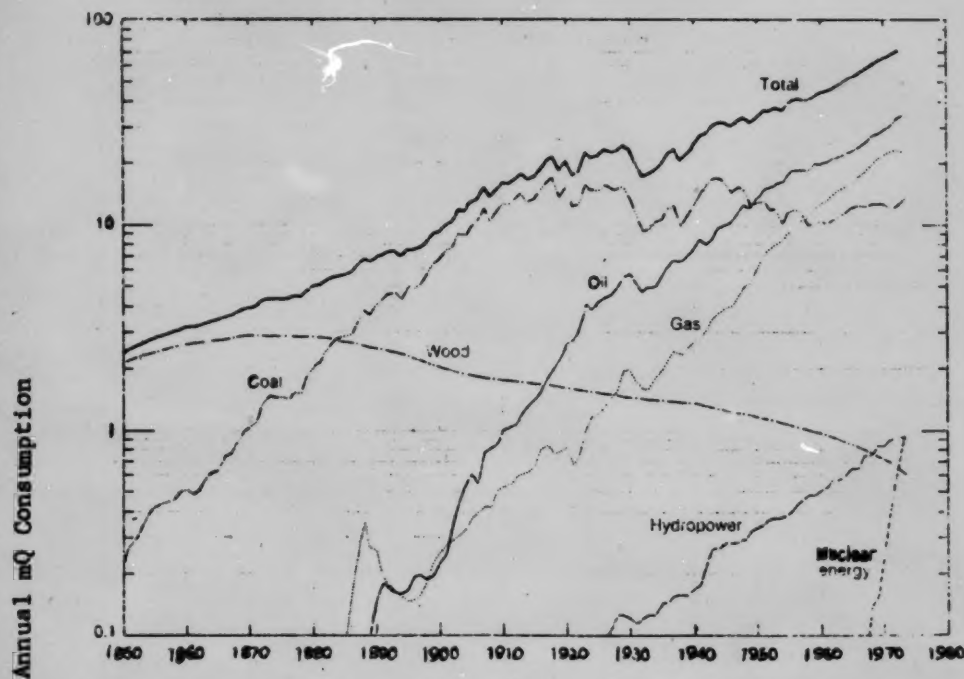
STUDENT ACTIVITIES

- ...Find out the population in 1965 and figure the annual per capita consumption for 1965.
- ...Compare your figures from 1865 to 1965 and find out how much per capita consumption increased in just 100 years. Try to explain this increase.
- ...Define and explain an mQ.
- ...Predict the annual energy consumption in the year 1980.

Discuss the ethics of a group or individual that uses a disproportionate share of a resource. What do you consider a disproportionate share? (Teacher note: After the above discussion, present students with the following for further discussion--"The U. S. with 7% of the world's population, uses 33% of the world's present energy supply." Points to consider in this discussion: Medical advances, technological advances.)

RESOURCES

GRAPH #1
U.S. Energy Consumption
1850 - 1974



an "mQ" is equivalent to 10^{15} BTU's

CONTENT

STUDENT OBJECTIVES

The student will be able to:

Construct and interpret graphs explaining energy use.

STUDENT ACTIVITIES

Groups within the class may use Almanacs to find the percent of energy used by the following sectors of our economy: industrial, transportation, residential, and commercial. Make circular graphs.

Construct graphs of your own design using the following data and give two suggestions for saving energy in each category.

<u>Home Energy User</u>	<u>% of Total Energy Used</u>
Space Heating	48%
Air Conditioning	19
Water Heating	16
Clothes Dryer	3
Refrigeration	3
Range	5
Freezer	4
Small Appliances	1
Lighting	1
<u>Transportation Energy User</u>	
Autos	53%
Trucks and Buses	22
Aviation	13
Agriculture	5
Boats and Ships	4
Railroad	3

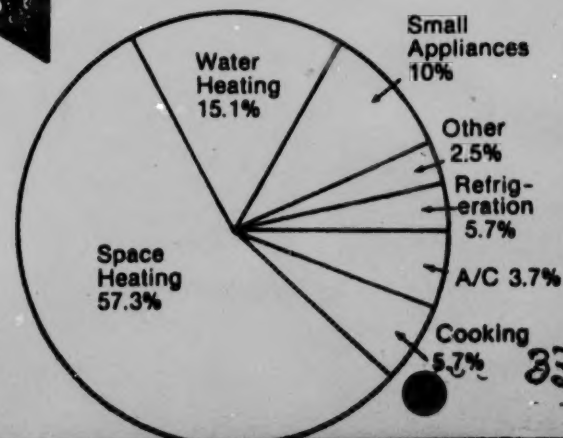
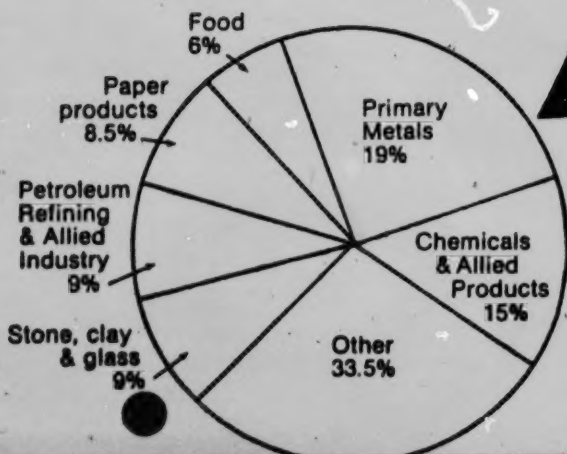
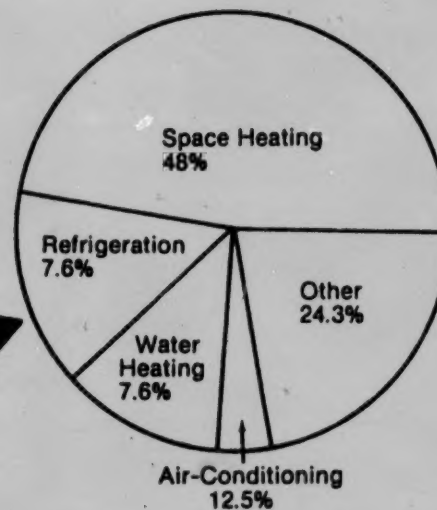
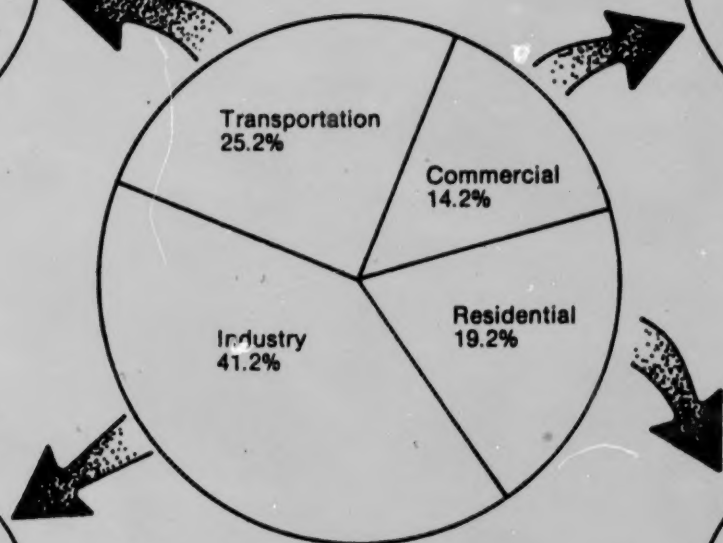
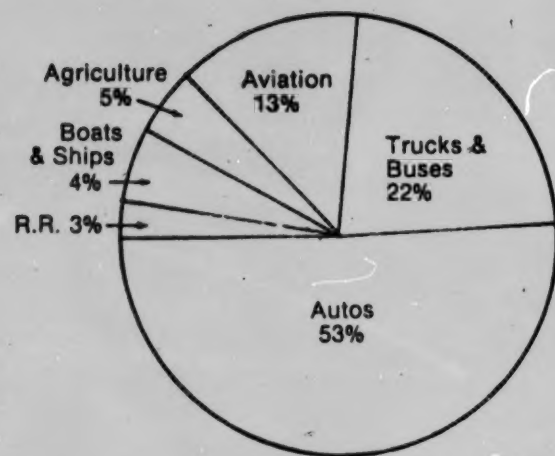
RESOURCES

Almanacs
Teacher Chart #1 (page 12).

S. C. Wildlife, "Energy on a Budget," September-October 1976.

TEACHER CHART

ENERGY USE BY SECTOR OF THE ECONOMY



CONTENT

STUDENT OBJECTIVES

The student will be able to:

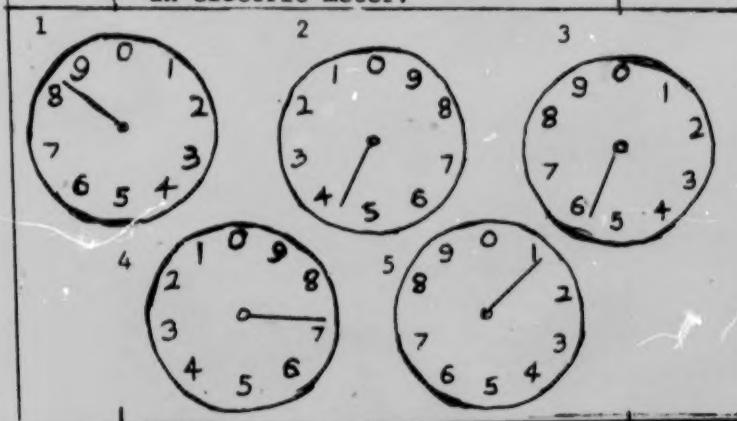
Read an electric meter.

STUDENT ACTIVITIES

Invite your power company representative to explain how to read an electric meter.

RESOURCES

Power company representative.



(An electric meter records the amount of electricity used in a home in kilowatt hours kWh.)

Each meter dial shows one-tenth of the dial on its left; i.e., units tens, hundreds, thousands, and ten-thousands. The pointers on the first, third, and fifth dials move clockwise, and the second and fourth move counterclockwise. To read a meter, start with the right hand dial and read left. If the pointer is directly on a number, read the next smaller number unless the pointer on the dial at its right has passed zero. As an example the dials above show 84,571 kWh.

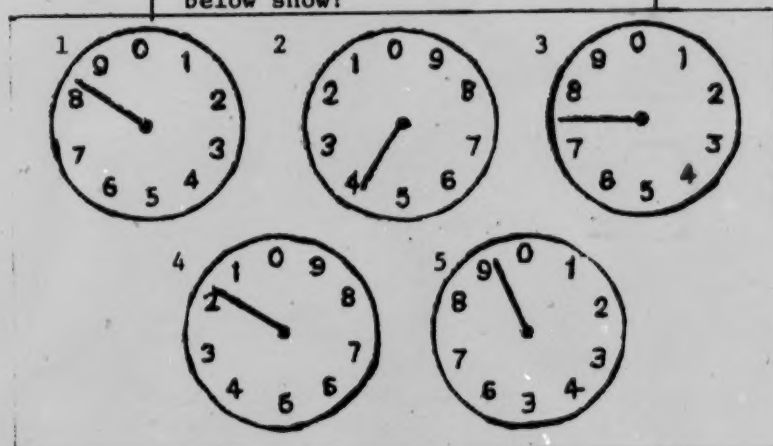
CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

How many kWh's does the meter below show?



RESOURCES

Determine how much electricity a family uses in one month.

Using the meter readings in the last activities, determine how many kWh's were used by a family. Assume the first reading was done in January and the second in February.

- Look at the electric meter in your home. What figure does it show?
- Look at the meter every day for a week. Can you tell how much electricity your family uses each day? How much did you use in a week?

CONTENT

STUDENT OBJECTIVES

The student will be able to:

Read a gas meter.

Construct and interpret a graph of energy use over a period of time.

STUDENT ACTIVITIES

- c. Find out from your local utility how much it charges per kWh of electricity. How much does it cost your family to use electricity in one week?
- d. Show your daily energy use on a bar or line graph covering a period of a week.

Learn to read your home gas meter (if you use natural gas). How many cubic feet of natural gas does your family use in a week?

If your school uses natural gas, confer with the person in charge, and determine the amount of natural gas used by your school in an average day.

Construct a line graph with all four categories on the same graph. Use the information (page 16). Answer the following:

- a. Calculate percent increase of each fuel to find out which energy source has increased its cost the most.
- b. How does the percent increase in cost of energy sources compare to the consumer price index?
- c. Can you explain your results?

RESOURCES

CONTENT

STUDENT OBJECTIVES

STUDENT ACTIVITIES

RESOURCES

The student will be able to:

Prices of energy sources 1960-1974.

	Electricity (1 kWh)	Natural gas (1000 ft ³)	Fuel oil (1 gal)	Gasoline (1 gal)	Consumer price index (1967 = 100)
1960	2.47¢	\$0.97	15.0¢	31.1¢	88.7
1961	2.45¢	\$0.98	15.6¢	30.8¢	89.6
1962	2.41¢	\$0.98	15.6¢	30.6¢	90.6
1963	2.37¢	\$0.98	16.0¢	30.4¢	91.7
1964	2.31¢	\$0.98	15.7¢	30.4¢	92.9
1965	2.25¢	\$0.98	16.0¢	31.2¢	94.5
1966	2.20¢	\$0.99	16.4¢	32.1¢	97.2
1967	2.17¢	\$0.99	17.0¢	33.6¢	100.0
1968	2.12¢	\$1.00	17.8¢	33.7¢	104.2
1969	2.09¢	\$1.02	17.9¢	34.8¢	109.8
1970	2.10¢	\$1.07	18.5¢	35.7¢	116.3
1971	2.19¢	\$1.15	19.7¢	36.4¢	121.3
1972	2.29¢	\$1.21	19.8¢	37.2¢	125.3
1973	2.38¢	\$1.27	23.0¢	39.0¢	133.1
1974	3.20¢	\$1.50	36.8¢	53.0¢	147.7

Identify examples of energy waste.

Evaluate home purchase from an energy saving point of view.

Take pictures of examples of excessive energy consumption. Sponsor an energy crisis picture contest.

Evaluate the purchase of a home from an energy consumption point of view (i.e., amount of insulation, storm windows and doors, effective heating system, length of hot water lines and their insulation, etc. Construct a check list for future home buyers and owners.

Home Energy Savers Workbook.

CONTENT

Development of energy resources for the future will require solution of technological and environmental problems.

STUDENT OBJECTIVES

The student will be able to:

Weigh various factors in deciding limited fuel allocation.

Explain the fuel consumption of different engines--small and large, tuned and untuned.

Explain the energy crisis.

Identify and list the world supply of potential fossil fuels.

STUDENT ACTIVITIES

Set up a simulation game to discuss and determine the allocation of a limited supply of energy and fuel. Divide the class into the following interest groups: manufacturers, environmentalists, community planners, oil companies, coal mine owners, foresters, educators, textile mill owners, workers, farmers, children.

After each group has presented its position, take a vote as to the equitable allocation of energy to each segment of the community

Optional: Working with small engines or car engines, find the amount of fuel a small engine consumes when it is out of tune, compared to when it is properly adjusted. Measure on a time basis at a given rpm.

View "When the Circuit Breaks."
Discuss your reactions.

Observe "Energy 2000" for class discussion.

RESOURCES

Film from the S. C. Energy Management Office or A-V Library.

Film from the S. C. Energy Management Office or A-V Library.

CONTENT

STUDENT OBJECTIVES

The student will be able to:

Evaluate the economic incentive problems posed by oil and gas exploration.

List the environmental problems associated with oil and gas production in newly developed fields.

Identify problems arising in coal production, both underground and stripmining.

STUDENT ACTIVITIES

View the filmstrip "Energy in the Earth." Do additional research. Begin a chart to keep a record of your findings. (See page 19.)

View "Fossil Fuels" and add to your chart.

It is August 1990; the view from your helicopter isn't pretty-- mile upon mile of look-alike suburban homes, sprawling freeways and smog. The population of Charleston County has doubled in 15 years. But the petroleum experts flying with you over Charleston are looking beyond the land. Out there, in the sea there's been a spill. No one knows precisely what caused it, but it's been known since long before the first well was dug off the coast that such a thing could happen. Using the suggested resources, predict what could happen to the East coast because of this spill.

Is it worth the economic stimulus it has provided to our state? Explain.

RESOURCES

Chart (p. 19).
Filmstrip from This World of Energy from Department of Education, Environmental Education Office.

World of Energy.

S. C. Wildlife, "Off-shore Oil--Is it Worth the Risk, November-December 1974.

STUDENT CHART

FACTS ABOUT ENERGY RESOURCES

Energy Source	Availability	State of Technology	Economics	Environmental and Health Considerations
Coal	Top grades almost gone; lower grades abundant	Well-developed	Relatively inexpensive	Strip mining Deep mining Air pollution
Oil				
Natural Gas				
Nuclear				
Geothermal				
Solar				
Solid Wastes				
Wind				
Ocean Thermal gradients				
Hydroelectric				
Tidal				

CONTENT

STUDENT OBJECTIVES

The student will be able to:

Identify the major problems associated with coal gasification and liquefaction.

STUDENT ACTIVITIES

Visit the energy production center which supplies your local energy needs. Ask questions about their use of energy, include problems associated with coal and coal gasification and liquefaction. Some possible questions could include:

1. What is net output of energy from this plant at peak load?
2. What is peak load pricing?
3. What times of the day do peak loads occur?
4. What plans have been developed for dealing with increased peak loads?
5. How does the energy input in fuel consumption compare with the net energy output?
6. What anti-pollution control measures are used at this power plant? (Include thermal pollution.)
7. What is the present rate per kWh at this plant? Is it different for industries?
8. How many years do you expect to be able to use this same type of fuel?

Research the environmental problems in coal production and decide what restrictions should be placed on future production.

RESOURCES

"A Second Coal Age,"
Smithsonian, August 1977.

CONTENT

Production of electricity from nuclear fission will require solution of reactor safety and waste disposal problems.

STUDENT OBJECTIVES

The student will be able to:

Identify the advantages and disadvantages of using nuclear fission for the production of electricity.

List the advantages and problems connected with nuclear fusion.

STUDENT ACTIVITIES

Decide upon the best location for an oil pipeline from Charleston to Columbia. Locate the line on a map of S. C. and defend your choice, aesthetically, environmentally, economically, and politically. What problems would be presented if this coal was being transported by train ?

Keep a notebook on articles, stories, etc., that you find in newspapers, magazines and other publications on current events in regard to new and existing energy sources such as the Alaskan Pipeline, solar energy, degasification of coal, etc.

View "Nuclear Power" and add to your chart.

View "The Park." In an essay evaluate the effect on the environment of a nuclear facility such as the Savannah River Plant.

Look up information on nuclear fusion and explain its potential--pros and cons for future use.

Arrange a field trip to the Savannah River Plant or a nuclear power plant.

RESOURCES

"Alternate Fuels from Coal," Chemtech, July 1977.
Map of South Carolina.

School library.

Film by National Geographic.
Film from ERDA.

Visit a Nuclear Power Plant (Ex., Keeowee or V. C. Summer plants).

CONTENT

Solar radiation is an important non-polluting source of energy.

STUDENT OBJECTIVES

The student will be able to:

Identify the presently developed minor sources of energy, and estimate their contribution to the total supply.

Identify the most likely new sources of energy for the future and to list the most difficult problems to be overcome with each.

STUDENT ACTIVITIES

Do research and make a class report on the disposal of nuclear wastes. How does the Barnwell plant fit into this picture? How does S. C. fit into the national plan?

View "Harnessing the Sun" and add to your chart.

View "Here Comes the Sun" and discuss in class the conclusions you reach from the facts presented.

Construct your own solar hot water heater or a solar powered parabolic boiler.

Purpose: Here's an experiment to help you find out what happens when different materials are used for insulation against solar energy.

Material: 3 empty $\frac{1}{2}$ pint milk cartons, 3 thermometers, material for insulation, (i.e., different types of cloth, aluminum foil, packing materials, papers, etc.) incandescent light source for heat.

RESOURCES

"The Disposal of Radioactive Wastes from Fission Reactors," Scientific American, June 1977.

Filmstrips:

"Harnessing the Sun," National Geographic; "Here Comes the Sun" Energy Conservation, Experiments You Can Do. "How Hot is Solar Energy," Environmental Science and Technology, July 1977. NASA, Report to Educators, May 1, 1977. "Energy for the Future," National Geographic. Film: "Which Energy," SCE & G.

CONTENT

54

STUDENT OBJECTIVES

The student will be able to:

23

STUDENT ACTIVITIES

Procedure: Each group of 3 students choose 3 different materials and carefully wrap your 3 milk cartons. Place a thermometer through the opening into the carton. Place each carton equal distances from a heat source. Record the beginning temperature, turn on the light and record temperature readings every 5 minutes for 15 minutes.

Results: Which material, according to your experiment, was the best insulator? Compare class results. Which material was the best insulator in the class?

(Optional) Research the problems associated with large-scale production of solar energy. Be sure to include the land-area use, transportation problems, and the economics involved. Give a concise, informative report to your class. (If you prefer, you may substitute nuclear fusion for solar energy as your research problem.)

View "Energy for the Future" and add to your chart.

View "Which Energy" and add to your chart.

RESOURCES

55

CONTENT

Personal conservation measures and national conservation policies must be carefully chosen and swiftly implemented.

STUDENT OBJECTIVES

The student will be able to:

List energy conservation measures he can take in his personal life.

Identify energy conservation measures which can be employed in residential buildings.

Identify and evaluate the major issues in national energy conservation policies.

STUDENT ACTIVITIES

Look around your home. Find 24 items which require energy (no duplication, like 2 light bulbs). Cross out the items on the list which you could really do without in order to save energy, especially during a power shortage.

Americans now use more energy than ever before for two reasons: there are many more Americans and each person uses more machines. Using your list of appliances from Activity 1, talk to your parents and place a check in the first column by each appliance they had when they were young. Then ask your grandparents, or someone their age, and place a check in the second column beside appliances they had when they were young. When you finish you will see one major reason why we are using more energy than ever.

Select any item from your list. List the kind of energy associated with it such as: what energy makes it run? Does it transform energy from one kind to another? Does it store energy? What kind? What kinds of energy were used in its manufacture?

RESOURCES

Energy Conservation, U. S. Printing Office.

Newsweek, newspapers, Time, U. S. News and World Report, etc.

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

RESOURCES

Write to the S. C. Energy Management Office or your power company for information on what you can do to save energy. Put as many of the suggestions as you can into practice in your personal life, at home and at school!

Go back to the record of your week of meter readings. Now work on a plan with your family on how you can cut down on the use of that energy for one week. Write down your plan and try to get everyone to agree to follow it. Again measure the amount of electricity used over a week when your family was following your conservation plan. How much did you save? What other factors such as cold or hot weather make a difference?

Find out which types of clothing retain body heat and remain comfortable in a residence or working place with a reduced temperature. Include clothing that is used for work as well as dress.

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

RESOURCES

Keep a record of the number of times (per week) trips from home have been made in the family car when, with planning, one trip might have been sufficient. Compile class results and devise a plan for reduction of travel. Compute class totals or averages of unnecessary mileage before and after conservation plan is implemented. Show comparisons on a bar graph.

Date	Purpose	Miles

There are many ways you can make your home more energy efficient. Try the following project. Check all the outside doors of your home, including any door into an unheated attic or garage, to see whether there are cracks where a door frame meets the wall. Look along the edges of the frame, both inside and outside the house. For only a few dollars, your parents can get a caulking gun and a tube of white caulking at a hardware store. Fill any cracks with caulking on both sides of the door. Do the same for window frames.

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

RESOURCES

A Project To Do: Energy Survey.

Much energy is wasted by our towns and cities. Shops may leave doors open when they are using energy to cool their buildings, office lights may be left on overnight, monuments may be flood-lighted, or restaurants may be kept too cold with air-conditioning.

You can help your town or city by keeping a notebook of energy being wasted and the address of the place wasting it.

With your classmates list all the places you have all found wasting energy. After three or more class members have confirmed each energy waster on the list, have a class debate to decide if that use of energy is really wasteful. After the debate and a class vote, write letters to the three addresses considered to be wasting the most energy. Explain in your letter the national need to conserve energy, the class project you have undertaken, and the way you think energy is being wasted. Try to be helpful and suggest ways that the same job can be done with less energy.

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

Survey your local automobile dealers on the following: Should the government limit the horsepower of cars? Should better gas mileage be a requirement of all new cars? Should advertising be restricted to compact cars? What changes should and could be made in the automobile industry to help reduce energy consumption?

Talk to your parents about a new kind of vacation this year. Rather than driving from one motel to another, find one motel to spend the whole vacation. Ask a travel agent for ideas for resorts with tennis courts, backpacking, swimming, nature walks, and other energy-conserving activities.

A recent news report stated that large quantities of scrap aluminum are being exported. Compare the energy cost of recycling scrap aluminum to that of producing it from bauxite.

RESOURCES

Energy Conservation.

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

The chart shown tells how much energy it takes to manufacture a product compared to how much energy the product will use in a year. Discuss the significances of this data in regard to actual need by a family. What could be done about this?

RESOURCES

Energy in Manufacturing

Product	Energy to Produce	Energy to Use
Carving Knife	20	1
Can Opener	17	1
Garage Door Opener	50	1
Garbage Disposal	30	1
Trash Compactor	20	1

Interview 10 friends and neighbors about electrical payment policy. Ask them to respond to a proposed policy to charge more as a home's or industry's use of electricity increases, rather than the present general policy which reduces charges for each kilowatt hour as consumption increases. How do they justify their response?

View "Energy Crisis--What We Can Do," Part I.

Filmstrip: "Energy Crisis--What We Can Do."

CONTENT

STUDNET OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

RESOURCES

Arrange to study the operation and maintenance of your school, and discuss possible improvements with the principal and the engineer-custodian. Is the furnace system operated at peak efficiency? At what temperature is the thermostat for each room set? Are empty rooms heated or air-conditioned? How long has it been since the furnace was serviced? Does the air-circulating system get regular replacement of filters? How much of the total energy consumed is used between 4 p.m. and the next morning? (Read the school meters.) Is that when most of the custodians are at work? Do they shut off, indeed, can they shut off the lights, heating, ventilating, and air-conditioning equipment in rooms as they finish their work? If not, could switches be installed, at low cost, which could enable them to do so? Could clean-up be done during the day without interfering with school work? Is natural light sufficient in the classrooms and hallways? If so, could the electric light be dimmed? Does the maintenance department own a light meter, and if not, shouldn't they buy one?

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

RESOURCES

Con't.

Borrow a light meter and measure the light in each room. The Federal Energy Administration recommends lighting levels of 50 footcandles at desks, 30 footcandles in rooms and work areas, and 10 footcandles in non-working areas such as halls and storerooms. Are the lights left burning all the time in the cafeteria and other spaces occupied only part of the day? You can also develop a plan for changes in the building which will conserve energy. Could the doors and windows be caulked to avoid heat loss? Could the attic have insulation added without major expense? Should plastic sheeting be placed over the windows to act as inexpensive storm windows?

Organize a debate on the following: "An individual's use of energy can be limited without undue loss of personal freedom." Be sure to include such issues as price deregulation, gas tax, and automobile EPA standards.

RESOURCE BIBLIOGRAPHY

Baxter, Tom. "Offshore Oil - Is it Worth the Risk," S. C. Wildlife, November-December 1974.

Baxter, Tom. "The Nuclear Future," S. C. Wildlife, January-February 1976.

Coon, Herbert L., and Michele Y. Alexander. Energy Activities for the Classroom. Columbus, Ohio: ERIC Center for Science, Mathematics, and Environmental Education, The Ohio State University, 1976.

Current Energy and Ecology. (Periodical for high schools and middle schools.) Highwood, Illinois: Publication and Subscription Offices, Curriculum Innovations, 501 Lake Forest Avenue. \$3.50 for subscription.

Current titles from the Department of Energy include:

1. "The Energy We Use," grade 1.
2. "Community Workers and the Energy They Use," grade 2.
3. "People, Places and Transportation," grade 3 (draft).
4. "Energy Networks," grade 4.
5. "The Study of Two Gulfs," grade 6 (draft).
6. "Bringing Energy to People: Ghana and the U. S.," grades 7-9 (draft).
7. "The Mathematics of Energy," grades 8-9 (draft).
8. "An Energy History of the United States," grade 8 (draft).
9. "Energy, Engines and the Industrial Revolution," grades 8-9.
10. "How a Bill Becomes a Law to Conserve Energy," grades 9, 11, 12.
11. "Energy in the Global Marketplace," grade 10 (draft).
12. "Agriculture, Energy and Society," grades 10-12.
13. "The New Westward Movement," grade 11 (draft).
14. "The U. S. Energy Policy--Which Direction?" grade 10 (draft).
15. "Energy for the Future," grade 12 (draft).

Eccli, Eugene, and Sandra Eccli. Save Energy: Save Money, Community Services Administration, Pamphlet 6143-5, Office of Economic Opportunity, Washington, D. C., 1974.

Eckholm, Erik. The Other Energy Crisis: Firewood. World Watch Papers, Washington, D. C.: 1975, World Watch Institute, 1776 Massachusetts Ave., N.W.

Energy posters designed for school use are available by writing to: Marie Lauricella, IIEQ, 309 W. Washington Street, Chicago, Illinois 60666.

Energy Conservation--a source book of free loan films on energy and the environment contains energy conservation experiments from American Petroleum Institute. Write: American Petroleum Institute, 2101 L Street, N.W., Washington, D. C. 20037.

Energy Conservation, Experiments You Can Do, 1975, Thomas Alva Edison Foundation, Inc., available from Thomas Alva Edison Foundation, Cambridge Office Plaza, Suite 143, 18280 West Ten Mile Road, Southfield, Michigan 48075.

Energy Options, compiled by the League of Women Voters Education Fund, 1977.

Energy Reporter, published bi-monthly by the Federal Energy Administration, has articles, energy tips and free publication sources. Write to Energy Reporter Registration, Federal Energy Administration, Old Post Office Building, R307B, Washington, D. C. 20461.

Energy: Who's Doing What?, published by the National Recreation and Park Association, is a 45 page directory of citizen groups, university programs, non-profit organizations and corporations engaged in energy related projects. More than 200 groups are listed. Write to National Recreation and Park Association, 1601 N. Kent Street, Arlington, Virginia 22209.

Hayes, Denis. Energy for Development: Third World Options. Washington, D. C.: Worldwatch Institute, 1776 Massachusetts Avenue, N.W., 1977.

Hayes, Denis. Energy: The Case for Conservation, 1976.

Hayes, Denis. Energy: The Solar Prospect. Washington, D. C.: Worldwatch Institute, 1776 Massachusetts Avenue, N.W., 1977.

Hayes, Denis. Nuclear Power: The Fifth Horseman, 1976.

Hayes, Denis. The Solar Energy Timetable. Washington, D. C.: Worldwatch Institute, 1776 Massachusetts Avenue, N.W., 1978.

McGuire, Mary T., ed. Energy and Education. Washington, D. C.: National Science Teachers Association, 1977.

National Science Teachers Association. Interdisciplinary Student-Teacher Materials in Energy, Environment, and the Economy. Oak Ridge, Tennessee: U. S. Department of Energy, 1976.

Nolan, William T. "Energy Choices for Consumers." The Science Teacher 44(9):32-33 (1977).

Northwest Regional Educational Laboratory. Computer Technology Program, Environmental Education Units. Portland, Oregon: Northwest Regional Educational Laboratory, 1975-77.

Pollution Control Education Center. The Energy Challenge. Union, New Jersey: Pollution Control Education Center, Township of Union Public Schools, 1975.

Smith, Stephen M., et. al. Energy-Environment Mini-Unit Guide. Washington, D. C.: National Science Teachers Association, 1975.

Speight, Carol. "Energy on a Budget," S. C. Wildlife, September-October, 1976.

Terry, Mark, and Paul Witt. Energy and Order. San Francisco, California: Friends of the Earth, 1976.

The Department of Energy (DOE) has publications available about environmental issues, energy research and development which may be obtained by writing to Department of Energy, Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

"The Disposal of Radioactive Wastes from Fission Reactors," Scientific American, June 1977.

The Energy Challenge is an activity master program about our energy past, present and future for grades 5-8 and high school. Copies of the 24 masters are available from: The Energy Challenge, Box 14306, Dayton, Ohio 45414.

Available from South Carolina Energy Management Office:

Federal Energy Administration. Conservation and Environment Publications, FEA/D-77/068, Office of Energy Conservation and Environment, Washington, D. C., 1976.

_____. Energy Conservation, FEA/D-75/264, Washington, D. C., 1975.

_____. Home Energy Savers' Workbook, FEA/D-76/362, U. S. G. P. O., Washington, D. C., 1976.

_____. National Energy Outlook, Executive Summary, 1976, U. S. G. P. O., O-204-986, Washington, D. C., 1976.

_____. Sources, Resources, and Choices, Office of Public Affairs, Region IV, and WETV - Channel 30, Atlanta, Washington, D. C. (n.d.).

_____. Tips for Energy Savers, Office of Conservation and Environment, Washington, D. C., 1975.

Joint Council on Economic Education. The Economics of the Energy Problem, 1212 Avenue of The Americas, New York, 1975.

South Carolina Department of Education. The Energy Book, 1975.

For further information on energy materials contact:

1. Federal Energy Administration
1655 Peachtree Street, N.E.
Atlanta, Georgia 30309

2. S. C. Energy Management Office
Edgar A. Brown Building
1205 Pendleton Street
Columbia, South Carolina 29201

AUDIO-VISUAL RESOURCES FOR ENERGY UNITS

Films:

Energy: 2000. (SCE&G)

Park, The (28 minutes). Energy Research and Development Administration, Oak Ridge. (DOE)

Which Energy? (SCE&G)

Available from addresses below:

Department of Energy
Film Library
P. O. Box 62
Oak Ridge, Tennessee 37830

The following A-V materials may be borrowed for a one-week period from Alice Linder, Consultant, Environmental Education, S. C. Department of Education, 1429 Senate Street, 803 Rutledge Building, Columbia, S. C. 29201, phone: 758-2652.

Filmstrips:

"Energy Crisis: What We Can Do," The Alliance for Environmental Education.

"Harnessing the Sun," National Geographic Society, Washington, D. C. 1977.

"This World of Energy," contents: Energy in the Earth, Using Energy, Fossil Fuels, Nuclear Power, Energy for the Future, National Geographic Society, Washington, D. C. 1977.

Films from the A-V Library, S. C. Department of Education:

A Question of Balance
Atomic Power Today: Service with Safety
Energy: A Matter of Choices
Energy: Critical Choices Ahead
Energy for the Future
Energy vs. Ecology: The Great Debate
Here Comes the Sun
Joe's World

King Zog and the Energy Crunch
Living with Energy
No Turning Back
Oil
Power for a Nation
Refining
The Great Search
When the Circuit Breaks

ENERGY IQ TEST

IN GENERAL . . .

1. The United States uses more energy per capita than any other nation in the world.
2. There is no reason to worry about energy conservation, because solar energy will be here soon and we'll be able to make energy from the sun.
3. Almost 20% of all the energy consumed in the United States is used in our homes.
4. Energy conservation is useless, since we're eventually going to run out of energy anyway.

IN THE HOME . . .

5. Because the sun is hotter in the afternoon, you should always keep the draperies closed on all west windows to block out the hot sun.
6. Trees and shrubs on the sunny sides of your house provide extra shade and keep your house cooler in the summertime.
7. If the walls and roof of your home are adequately insulated, there is no need to weatherstrip doors and windows.

TRUE. Although we comprise only about 6% of the world's population, we use 36% of all energy consumed in the world, and that figure continues to rise.

FALSE. Answers to the energy problem, including the widespread use of solar energy, will come...but not for a decade or more. In the meantime, we are rapidly using up the existing energy supplies.

TRUE. And more than half of the energy we use in our homes goes into heating and cooling. If every one of the 70 million homes in the U. S. were to take an active part in conserving energy, it would mean a substantial savings in energy and lessen the probability of future shortages.

FALSE. Energy conservation is vital if we are to continue to maintain our current standards of living--much less, improve it--and for the nation to keep a solid economic growth. This is important as we develop new technologies to meet the goal of an energy self-sufficient nation in the next decades.

TRUE & This is true in the summer, but false in the winter.
FALSE. In summer, keep draperies pulled closed to block the hot sun out. In winter, keep them open and let the sun into the room for extra heat.

TRUE. Check with your local nursery, they can help you find inexpensive, fast-growing trees.

FALSE. You can save as much as ten percent on your energy bill by weatherstripping.

8. On especially cold winter days, a roaring fire can really save energy.

9. Check your furnace and air conditioning filters at least once a year, you'll save energy.

10. On especially cold days, it's a good idea to get a little extra heat into the kitchen by turning on the oven, and opening the oven door.

IN THE KITCHEN AND BATH . . .

11. The lower the temperature setting on the hot water heater, the less energy you will use.

12. In your refrigerator/freezer, frost acts as an insulator and keeps food cooler. Therefore, you use less energy.

13. The more you open the refrigerator door, the more energy you use.

14. Small appliances such as toasters, electric skillets, and popcorn poppers generally use less energy for specific jobs than a range does.

FALSE. Unless you have a system that re-circulates the heat from the fire throughout the heating system in your home, the heat from the fireplace will go up the flue and out the chimney. Be sure to always keep the damper to your fireplace closed--especially on cold winter days.

FALSE. Experts suggest that you check the filters more often, and some suggest you check them at least once a month--particularly if you have carpet--to get the most efficiency from your unit.

FALSE. You use more energy because you have two energy consuming items on in your home at the same time, and an oven is a very costly way to heat your home.

TRUE. You can regulate the temperature of your hot water heater by the thermostat. A setting between 120 and 140 degrees is usually adequate for an average family. The higher the setting, the higher your energy bill. Check the setting on your water heater.

FALSE. Your refrigerator cools by removing heated air. Frost will act as an insulator, all right...it keeps the heat in the food, and consequently makes the refrigerator work harder to remove warm air. Never let the frost accumulate more than $\frac{1}{2}$ inch.

TRUE. Know what you're looking for before you open the refrigerator door. Standing there with the door open costs money and lots of energy.

TRUE. These special appliances are also designed to do specific jobs, so they make some cooking easier.

15. You can save energy by covering the saucepans when cooking, because the food cooks faster.
16. Clean surface unit reflector pans on your range increase energy efficiency.
17. By using cold and warm cycles in your washing machine, you'll save energy and money.
18. You'll save energy by doing several small loads of wash rather than one large load.
19. It's a good idea to get as many clothes into the dryer as possible, so you won't have to run the dryer too many times and use unnecessary energy.
20. You should run the dishwasher as soon as it is partially filled.
21. Turning the dishwasher off when the wash portion of the cycle is complete, saves energy.
22. A garbage compactor uses a great deal of energy, and is not economically feasible.

- TRUE. Foods cook faster when the saucepans are covered, and the kitchen stays cooler as well. Turn the heat off a few minutes before the food is completely cooked; retained heat will complete the cooking.
- TRUE. Also when you use the self-clean feature (if your oven has one), why not wait until after you have used the oven for your evening meal. Less energy will be required to heat up to the cleaning temperature.
- TRUE. Much of the energy used in doing your family wash goes to heat the wash water. Select a cold water soap recommended for your machine brand, and your energy bill should decrease.
- FALSE. Large capacity washer and dryers can handle in one load what small washers and dryers must do in two loads. This saves energy.
- FALSE. You should sort clothes by thickness before you place them in the dryer. Otherwise, it takes more energy to run the extra cycle for only one or two slow drying items.
- FALSE. Always run the dishwasher when it is filled to capacity. Accumulate dishes from several meals before you run the dishwasher, it saves money and energy.
- TRUE. If you don't need dry dishes immediately, turn the machine off and open the door slightly. The dishes will dry by themselves, and you can save about one-half the power consumed in a normal cycle.
- FALSE. The garbage compactor, besides being a great convenience, is extremely inexpensive to operate. It only costs about \$.10 a year in energy costs for the average family of four.

23. The iron is one of the least energy consuming appliances in your home.

ON THE ROAD . . .

24. About one-third of all private automobile mileage is for commuting to and from work.
25. The operating efficiency of your car is directly related to the energy efficiency of your car.
26. Always be certain to warm up your car for 5 to 10 minutes on cold days.
27. The less air in the tires, the less gasoline you will burn.
28. There is no difference between steel-belted radials and other tires when it comes to gas mileage.
29. The heavier the car, the more gas it uses.
30. The 55 mph speed limit was imposed during the oil embargo to make sure there was enough gas to go around. Soon, we'll be driving at higher speeds again.

FALSE. A hand iron consumes as much energy as ten 100 watt light bulbs. Buy no-iron sheets and clothing, permanent press, and remember to iron large batches of clothing at one time. This avoids wasting energy reheating the iron several times.

TRUE. Join a carpool.

TRUE. The smoother your engine runs, the less energy it will require to operate it.

FALSE. It's unnecessary to warm a car up for that long a period of time. Also, if you plan to stop for one minute or more, turn your car off. It requires less energy to start up the car again, than it requires to idle for that period of time.

FALSE. Check air pressure in your tires regularly. Under-inflated tires increase gas consumption.

FALSE. Steel belted radials give better mileage and last longer. But never mix radials with conventional tires.

TRUE. Always remove unnecessary weight from the car.

FALSE. The 55 mph speed limit is here to stay. It has saved perhaps more energy than any other conservation method thus far. Besides, take your time when you're driving. You'll enjoy the countryside more, and run a better chance of getting to your destination in one piece.

An Overview of
ENERGY ALTERNATIVES

by

Dr. Robert R. Furgason
Dean, College of Engineering
University of Idaho
Moscow, Idaho 83843

THE STARTING POINT

This presentation examines the various energy sources that are potential alternatives to the use of petroleum and natural gas for the U.S. Implicit in all discussions is that petroleum and natural gas are in short supply and that energy alternatives must be developed. This presentation does not attempt to justify the above premise since such a discussion deserves an equal or greater time requirement. Also, the subject of energy conservation is not addressed even though it is my opinion that conservation should have a number one priority in development of energy policies. This presentation is limited to the question, "What are our energy alternatives and how do they rank in future development?"

Our world desperately needs an energy utilization and development plan, and it will be up to the U.S. to exert the leadership in energy planning since it is such a large consumer of energy. Yet there is little indication at this time that our governmental leaders are facing up to these responsibilities. This is a time of crisis and more attention must be given to statesmanship and less to political popularity. The people of the U.S. must be made aware of the fact that much of our financial resources and personal efforts must go toward providing the basic necessities of energy, materials and food for our current and future generations, and that to do so will quite likely require substantial departures from our current mode of living.

TIME FACTORS

Time is an important dimension when energy alternatives are examined. The time factor will dictate many times what can be done, regardless of availability, desirability, economic factors, etc. Crash programs can only crash so fast. Likewise, the amount of people power available and trained to do a job quite possibly can pose a constraint which requires time to rectify. Thus, every alternative must be viewed in relation to its place in a time frame as well as its general characteristics such as amount, location, hazards, etc.

Some examples:

- | | |
|--|------------------|
| - concept to usable product | 10 years minimum |
| - build a new plant | 2-5 years |
| - obtain a mine drag line | 8 years |
| - approve, design and construct a conventional nuclear power plant | 8-14 years |

The point is that a decision today requires literally years to become a part of reality.

TECHNOLOGY

There is a general public misunderstanding between knowledge of a concept or phenomena and developing the concept to the point where it can be utilized on a large scale by a significant portion of the population. The development and application of technology is concerned with this latter area and must be compatible with economic feasibility, environmental quality, public acceptance and similar factors. Scientific concepts and facts can be regarded as "known" but technology is in an everchanging mode, thus, statements to the effect that--"the technology is known, all we need is to come up with cheap and reliable systems" is a complete contradiction of terms. An overwhelming percentage of the time spent by an engineer is directed toward the production of cheap and reliable systems.

CURRENT ENERGY USE

Before examining alternatives, an analysis of current energy usage must be made relative to who uses the energy, where it comes from, and how it is being used--user, source and end use.

There is no single sector of our society that dominates the use of our energy. All must do their part in approaching the energy problem. The current use is distributed as follows:

Residential	20%
Commercial	15
Industrial	40
Transportation	25

The foregoing users derive their energy from the following sources:

Petroleum	45%
Natural gas	31
Coal	20
Hydro power	4
Nuclear	1

If our objective is to shift from petroleum and natural gas, the challenge is immense since these two energy sources constitute about three-quarters of our current energy demand.

The various classifications of users all are heavily dependent on petroleum and natural gas with only the industrial sector making much current use of coal.

<u>User</u>	<u>Oil</u>	<u>Nat. Gas</u>	<u>Coal</u>
Residential	45%	52%	3%
Commercial	40	60	1
Industrial	49	29	22
Transportation	96	4	--

Although electricity is widely used, it is an energy transportation system and is not a source of energy. Electrical generation comes from the following sources:

Petroleum	11%
Natural gas	24
Coal	49
Hydro power	15
Nuclear	1

Finally, the end uses must be examined since an alternate energy source for space heating may not be feasible

for transportation. Of major significance is that space heating, air conditioning and water heating account for 70-75% of the end use in both the residential and commercial sectors. Thus, such alternatives as solar energy may have a significant impact in these areas but essentially no effect with regard to transportation.

ALTERNATE SOURCES

Coal

- Large reserves - 100 to 200 years' supply at current energy use rate.
- Conversion to electricity is current practice.
- Can be converted to a gas or oil product but considerable development necessary.
- Strip mining, water pollution and air pollution pose environmental hazards.
- Expensive land reclamation.
- High water usage in electrical generation and conversion to gas and oil.

Nuclear Fission (Conventional)

- Short supply of U^{235} - 30 years.
- Conversion to electricity is current practice.
- Electricity costs are competitive.
- Radioactive wastes are major environmental problem.
- New developments are needed.

Nuclear Fission (Breeder)

- Greatly increased fuel supply - natural uranium is 99.3% U^{238} and 0.7% U^{235} , also thorium is a source of fuel.
- High development costs since technology is not well established - \$10 billion.
- Plutonium is very toxic.

Nuclear Fusion

- Nearly inexhaustible supply of deuterium in water - 7,000 gal/1,000,000 gal. Lithium could be limiting but no real problem.
- Nuclear wastes are a minor problem.
- Temperature of reaction 100,000,000 °C - containment problem has not been solved.
- Scientific concepts and technology are not known.
- Distant future.

Solar Heating and Cooling

- Good potential for new residential and commercial buildings - perhaps can satisfy one-half of the needs by year 2000.
- Expensive equipment - previous estimates of \$4-6/ft.² now revised to \$10-12/ft.².
- Usually need storage capacity and back-up system.
- Limited life of collector system.

Solar Thermal Conversion

- Concentrate solar energy in collector to produce high temperatures.
- Can use conventional electricity generation systems once energy collected.
- Sun is intermittent source so need an expensive storage system.
- Large equipment investments.
- Aesthetics are a problem.

Solar Photovoltaic Conversion - Solar Cells

- Expensive \$30,000/kilowatt.
- Low efficiency 15-20%.
- Much development needed since materials are in short supply.
- Technically appealing.

Bioconversion

- Low percentage of solar energy is converted to a usable form.
- Electricity as a by-product of solid waste recycle systems is an important source.

Oil Shale & Tar Sands

- Large reserves available but net energy produced may be small.
- Environmental problems are significant particularly with shale.
- Processing consumes large quantities of water.
- Costly process 50,000 bbl/day - \$500,000,000.

Geothermal

- Large source of energy but only available in limited locations.
- Low efficiencies due to low temperatures of water systems.
- Difficult equipment due to scaling and corrosion.
- Environmental problems due to thermal pollution, escaped gases, and salts.
- Promising process energy source.

Wind

- Many windmills to obtain reasonable quantity of energy 500 KW/windmill.
- Few favorable sites but potential use in remote areas.
- Variable nature.

Ocean Tides

- Highest tides at the highest latitudes but this is not where the energy is needed.
- Salt water corrosion is a major problem.
- High cost.

Ocean Thermal Gradients

- High water volumes are required; thus equipment costs are high.
- Low efficiencies.
- Transmission problems due to salt water.

PROJECTIONS

In the short term (0-10 years) any new energy generation will come, by necessity, from coal and conventional nuclear fission. Development will be accelerated on other sources but their significance will be limited.

Over a longer term (10-50 years), utilization of coal by gasification and liquefaction should be widely practiced as well as continued use of coal for electrical generation. Developments of nuclear fission should be such that the breeder reactor is an important electrical generation system. Nuclear fusion is unlikely to be commercially developed. Solar energy will be widely used and the geothermal potential will probably be highly developed. Other energy source development appears to be quite questionable.

GENERAL ENERGY INFORMATION

1. 1976 Executive Summary: National Energy Outlook

Trellis Leonard
Special Services Representative
Shell Oil Company
P.O. Box 1563
Houston, Texas 77001

2. Our Energy Problems and Solutions

Energy Conservation Research
9 Birch Road
Malvern, Pennsylvania 19355

3. You Can't Escape the Energy Crisis But You Can Do Something About It

National Rural Electric Cooperative Assn.
2000 Florida Avenue, N.W.
Washington, D.C. 20009

4. Exxon Company, U.S.A.'s Energy Outlook, 1975-1990

Exxon Company, U.S.A.
Public Affairs Department
P.O. Box 2180
Houston, Texas 77001

5. A Battle Plan to Beat the Energy Crisis (by C.F. Luce)

Reprint Editor
Reader's Digest
Pleasantville, New York 10570

ENERGY CONSERVATION IN THE HOME

1. How to Save Money by Insulating Your Home: Practical Instructions and Advice on Doing it Yourself or Hiring a Contractor

National Mineral Wool Insulation Assn., Inc.
382 Springfield Avenue
Summit, New Jersey 07901

2. Energy . . . and the Consumer (adapted from the address of Robert D. Partridge, National Rural Electric Cooperative Association, 32nd Annual Meeting, San Francisco, California February 12, 1974)

National Rural Electric Cooperative Assn.
2000 Florida Avenue, N.W.
Washington, D.C. 20009

3. 76 Ways to Conserve Energy in Your Home

Columbia Gas System
20 Montchanin Road
Wilmington, Delaware 19807

4. How to Bring Your Fuel Bills Under Control

Owens-Corning Fiberglas Corporation
Home Building Products Division
Fiberglas Tower
Toledo, Ohio 43659

5. The NBS Energy-Related Invention Evaluation Program: What It Is and How It Works

U.S. Department of Commerce
National Bureau of Standards
Washington, D.C. 20234

6. Energy Conservation Experiments You Can Do . . from Edison

Thomas Alva Edison Foundation
Cambridge Office Plaza, Suite 143
18280 West Ten Mile Road
Southfield, Michigan 48075

ENERGY CONSERVATION IN THE HOME (cont.)

7. Save Energy: Save Money!

The National Center for Community Action
Network Services: Energy
1711 Connecticut Avenue, N.W.
Washington, D.C. 20009

8. A Mobile Home Dweller's Guide for Conserving Heating Fuel

Pennsylvania Department of Community Affairs
Industrialized and Mobile Housing Division
P.O. Box 155
Harrisburg, Pennsylvania 17120

9. Home Energy Saving Tips from NBS

U.S. Department of Commerce
National Bureau of Standards
Washington, D.C. 20234

10. The Arkansas Story: Report No. 1, Energy Conservation Ideas to Build On

Owens-Corning Fiberglas Corporation
Insulation Operating Division
Fiberglas Tower
Toledo, Ohio 43659

11. Annual Electric Energy Use and Cost (Based on West Virginia Electric Utilities)

West Virginia Fuel and Energy Division
1262½ Greenbrier Street
Charleston, West Virginia 25311

12. Here's Your Dictionary of Building Terms

West Virginia Fuel and Energy Division
1262½ Greenbrier Street
Charleston, West Virginia 25311

13. Cubic Feet: How to Read Your Gas Meter and Kilowatt Hours: How to Read Your Electric Meter

West Virginia Fuel and Energy Division
(see address above)

INSULATION

1. Energy Efficiency in Room Air Conditioners

U.S. Department of Commerce
National Bureau of Standards
Washington, D.C. 20234

2. 1977 Directory of Certified Room Air Conditioners

Association of Home Appliance Manufacturers
20 North Wacker Drive
Chicago, Illinois 60606

3. Interpretations of HUD-FHA Building Insulation Standards

National Mineral Wool Insulation Association, Inc.
382 Springfield Avenue
Suite 312
Summit, New Jersey 07901

4. Johns-Manville Fiber Glass Insulation for Light Frame Construction

Johns-Manville
Greenwood Plaza
Denver, Colorado 80217

5. Zonolite Insulation

Zonolite Construction Products Division
W. R. Grace & Co.
62 Whittemore Avenue
Cambridge, Massachusetts 02140

6. Zonolite ThermoClad: Exterior Wall Insulation and Finish System

Zonolite Construction Products Division
W. R. Grace & Co.
62 Whittemore Avenue
Cambridge, Massachusetts 02140

INSULATION (cont.)

7. Straight Talk About Savings on Energy and Maintenance Costs with Reynolds Aluminum Building Products

Reynolds Metals Company
Architectural and Building Products Divn.
Richmond, Virginia 23261

8. You Can Save \$130 to \$380 a Year on Your Heating and Air Conditioning Costs Because of the Energy Saving Totalwall Insulation System in This House

Dow Chemical U.S.A.
Construction Materials
Midland, Michigan 48640

- How to Insulate Concrete Floors with Styrofoam TG Brand Insulation

Dow Chemical U.S.A.
Construction Materials
Midland, Michigan 48640

10. How to Insulate Masonry Walls on the Inside with Styrofoam TG Brand Insulation

Dow Chemical U.S.A.
Construction Materials
Midland, Michigan 48640

11. Re-Siding? You Can Save on Heating and Air Conditioning Bills by Covering Your Old Siding First with Styrofoam TG Brand Insulation

Dow Chemical U.S.A.
Construction Materials
2020 Dow Center
Midland, Michigan 48640

12. Blowing Wool Application Manual

National Mineral Wool Insulation Assn, Inc.
211 East 51st Street
New York, New York 10022

13. All About Insulation: A Homeowner's Guide to Saving Energy and Lowering Fuel Costs

Owens-Corning Fiberglas Corporation
Insulation Operating Division
Fiberglas Tower
Toledo, Ohio 43659

14. You Need More Than Just More Insulation. You Need More Information. Johns-Manville Gives You Both . . .

The Johns-Manville Insulation Center
Drawer 17-L
Denver, Colorado 80217

15. Where the Dreams Begin . . . Where the Action Starts

National Rural Electric Cooperative Association
2000 Florida Avenue, N.W.
Washington, D.C. 20009

16. Energy: Knowing Where to Save Is As Important As Your Commitment to Help

American Sign and Indicator Corporation
P.O. Box 2727
Spokane, Washington 99220

ENERGY CONSERVATION ON THE ROAD

1. Ridesharing: A Better Way to Use Cars and Highways

U.S. Department of Transportation
Federal Highway Administration
Washington, D.C. 20590

2. Vanpools

U.S. Department of Transportation
Federal Highway Administration
Urban Planning Division
Washington, D.C. 20590

3. Manual Carpool Matching Methods

U.S. Department of Transportation
Federal Highway Administration
Urban Planning Division
Washington, D.C. 20590

4. Legal and Institutional Issues of Carpooling

U.S. Department of Transportation
Federal Highway Administration
Urban Planning Division
Washington, D.C. 20590

5. 1977 Gas Mileage Guide (September 1976)

U.S. Environmental Protection Agency
Washington, D.C. 20460

6. Gas Watchers' Guide

American Automobile Association
8111 Gatehouse Road
Falls Church, Virginia 22042

7. Clean Air and Your Car

Office of Public Affairs
U.S. Environmental Protection Agency
Washington, D.C. 20460

8. How to Drive for Maximum Economy

Mobile Oil Corporation
Products Division
150 East 42nd Street
New York, New York 10017

9. Why Unleaded Gas?

U.S. Environmental Protection Agency
Washington, D.C. 20460

10. Owners Operators: Fuel Savings Is \$\$ Savings

Department of Transportation
Office of the Secretary
Washington, D.C. 20590

11. Tips for Truckers: Radial Tires for Your Fleet?

Department of Transportation
Office of the Secretary
Washington, D.C. 20590

12. Tips for Truckers: Save Fuel by Slowing Down . . . Your Engine

Department of Transportation
Office of the Secretary
Washington, D.C. 20590

13. Trucker's Guide to Fuel Savings

Department of Transportation
Office of Secretary
Washington, D.C. 20590

14. Saving School Bus Fuel: Voluntary Truck and Bus Fuel Economy Improvement Program

Department of Transportation
Office of the Secretary
Washington, D.C. 20590

ENERGY MANAGEMENT

1. Energy Management for Colleges and Universities

ACE-APPA-NACUBO Energy Task Force
One Dupont Circle
Suite 510
Washington, D.C. 20036

2. Energy Management: Marketing Priorities and Energy

Office of Energy Programs
U.S. Department of Commerce
Washington, D.C. 20230

3. Industry's Vital Stake in Energy Management

Office of Energy Programs
U.S. Department of Commerce
Washington, D.C. 20230

4. 33 Money-Saving Ways to Conserve Energy in Your Business

Office of Energy Programs
U.S. Department of Commerce
Washington, D.C. 20230

5. Energy Management: Economic Sense for Retailers

Office of Energy Programs
U.S. Department of Commerce
Washington, D.C. 20230

6. How to Start an Energy Management Program

Office of Energy Programs
U.S. Department of Commerce
Washington, D.C. 20230

7. Energy Conservation Program Guide for Industry & Commerce

U.S. Department of Commerce
National Bureau of Standards
Washington, D.C. 20234

ELECTRICITY

1. Review of Overall Reliability and Adequacy of the North American Bulk Power Systems

National Electric Reliability Council
Research Park
Terhune Road
Princeton, New Jersey

2. Electric Power and the World Around Us

Appalachian Power Company
40 Franklin Road SW
Roanoke, Virginia 24009

3. Emergency Electric Energy Reduction for Industrial Customers

Tennessee Valley Authority
Power Marketing Division
Knoxville, Tennessee 37902

4. Residential Emergency Electric Energy Reduction

Tennessee Valley Authority
Power Marketing Division
Knoxville, Tennessee 37902

SOLAR ENERGY

1. Solar Water Heating: A Question and Answer Primer

Florida Solar Energy Center
300 State Road 401
Cape Canaveral, Florida 32920

OIL AND GAS

1. Natural Gas - The Cornerstone of U.S. Energy Policy,
Economic Well-Being

Public Relations Department
Columbia Gas System
20 Montchanin Road
Wilmington, Delaware 19807

2. The Natural Gas Shortage: What Can Be Done About It
(Excerpts from the 1974 Annual Report of the Columbia
Gas System, Inc.)

Columbia Gas System
20 Montchanin Road
Wilmington, Delaware 19807

3. New Sources of Gas . . . Where and When?
(A Progress Report from the American Gas Assn.)

American Gas Association
1515 Wilson Boulevard
Arlington, Virginia 22209

4. Don't Push the Messenger

American Petroleum Institute
2101 L Street Northwest
Washington, D.C. 20037

COAL

1. West Virginia Coal . . . More Important Than Ever

West Virginia Coal Association
1721 Kanawha Valley Building
P.O. Box 1111
Charleston, West Virginia 25324

2. Decision '75: Coal Is the Answer. Now.

National Coal Association
Coal Building
Washington, D.C. 20036

FOR YOUR ENERGY INFORMATION

USAGE CHART

The following list of appliances shows, in the first column, the average wattage of such an appliance; in the second column, the average number of hours the appliance is used in one year; and in the third column, the total number of kilowatt hours for each appliance over one year.

<u>APPLIANCE</u>	<u>AVERAGE WATTAGE</u>	<u>AVERAGE HOURS PER YEAR</u>	<u>kwh PER YEAR</u>	<u>RANK₁</u>
Air cleaner	50	4,320	210	5
Air conditioner	1,566	887	1,389	
Bed covering	177		147	
Blanket	177	831	147	
Blender	386	38.9	15	
Broiler	1,436	69.7	100	
Carving knife	92		8	
Clock	2	8,500	17	
Clothes Dryer	4,856	204	993	
Coffeemaker	894	119.0	106	
Deep fryer	1,448	57.3	83	
Dehumidifer	257	1,467	377	
Egg cooker	516		14	
Fan, attic	370	786	291	
Fan, circulating	88	489	43	
Fan, rollaway	171	807	138	
Fan, window	200	850	170	
Floor polisher	305	49.2	15	
Freezer, 15 cu. ft.	445	3,405	1,195	7
Freezer, frostless, 15 cu. ft.	440	4,002	1,761	4
Frying pan	1,196	157	188	
Germicidal lamp	20		141	
Hair dryer	381	36.7	14	
Heat lamp (infared)	250		13	
Heater, portable	1,322	133	176	
Heating pad	65	154	10	
Hot plate	1,257	71.6	90	
Humidifer	177	921	163	
Iron, hand	1,008	143	144	
Mixer	127	102	13	

<u>APPLIANCE</u>	<u>AVERAGE WATTAGE</u>	<u>AVERAGE HOURS PER YEAR</u>	<u>kwh PER YEAR</u>	<u>RANK₁</u>
Oven, microwave	1,500	200	300	
Oven, self clean	4,800	239	1,146	9
Radio	71	1,211	86	
Radio/rcr. player	109	1,000	109	
Range	8,200	128	1,175	8
Refrig. 12 cu. ft.	241	3,021	728	
Refrig./frostless, 12 cu. ft.	321	3,791	1,217	6
Refrig./frostless, 14 cu. ft.	326	3,448	1,137	10
Refrig./freezer, 14 cu. ft.	615	2,947	1,829	3
Roaster	1,333	154	205	
Sandwich grill	1,161		33	
Sewing machine	75	147	11	
Shaver	14	129	1.8	
Sun lamp	279	57.3	16	
Toaster	1,146	34	39	
Toothbrush	7	7.14	0.5	
Trash compactor	400	125	50	
TV, black & white	237	1,527	362	
TV, color	332	1,512	502	
Vacuum cleaner	630	73	46	
Vibrator	40	50	2	
Waffle iron	1,116	12.7	22	
Wash. mach. auto*	521	198	103	
Waste disposer	445	67.4	30	
Water heater	2,475	1,705	4,219	2
Water heater, quick recovery	4,474	1,705	4,811	1
Wash. mach. non auto*	286	266	76	

* does not include hot water heating

(1) Rank...ten greatest energy consumers in the home

WATER

"Water: A necessity of life--a transporter of disease--a sustainer of navigation, a coolant, cleanser, diluent--a medium for recreational pursuits--a resource with food for populations--a power source to harness and control--a source of tranquil, aesthetic enjoyment--a refuge for biological pests and nuisances--a defiled purveyor of civilization's wastes."¹

Our water comes from rain and snow. While the amounts remain about the same each year, our population is growing and per person use of water is increasing. In the U. S., the per person use of water is 4 times what it was in 1900. Industrial use of water is 13 times what it was in 1900 and irrigation use is up 7 times since 1900. Water is an essential and unique substance. Water has a variety of sources. Water is constantly being recycled. People alter and use so much water that conservation is imperative.

¹The Practice of Water Pollution. Federal Water Pollution Control Administration.

CONTENT

Water Cycle

The water cycle is nature's way of keeping water constantly moving and in use. The heat of the sun evaporates water from the surfaces of lakes, oceans and the soil. This moisture moves into the atmosphere where it cools and condenses to form clouds from which water returns to the earth as rain, snow, sleet, or hail. Some of this water soaks into the ground, and some runs off in streams, which feed rivers, which carries the water back to the ocean. Most of the water we use is first absorbed by the soil, then returned to the surface as seepage in springs, streams, and lakes, or by being pumped from wells. Because soil is a filter, the emerging water is usually clean and clear.

A water basin is a body of water fed by a watershed.

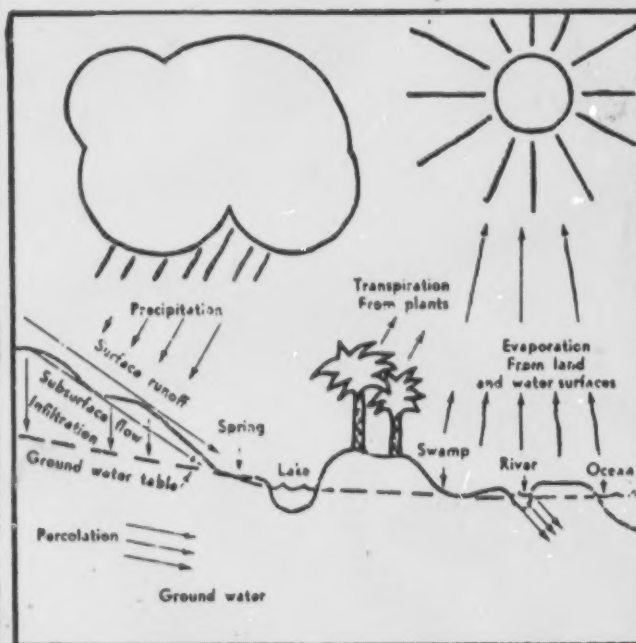
A watershed is the area drained by a given body of water, such as a river or stream.

119

STUDENT OBJECTIVES

The student will be able to:

Illustrate the hydrologic cycle, explaining how water proceeds through it.



Identify the major water basin in S. C. Describe and identify watersheds.

56

STUDENT ACTIVITIES

Water is continually moving through a cycle. Draw a water cycle beginning with vapors from the ocean. Discuss cycle and what factors affect it.

Label the major rivers of S. C. using a topographic map of a local area. Select a color legend and indicate watersheds on the maps.

RESOURCES

"An Overture," Vernon J. Tipton, American Biology Teacher, May 1977.

The Hydrologic Cycle.

"Water, Our Most Talented Resource." S. C. Wildlife, March-April 1971, pp. 78.

Subbasin Delineation Map, S. C. Water Resources Commission.

120

CONTENT

Water tests and quality

Public water systems are tested regularly by DHEC. Private wells and other water supplies may also be tested and evaluated if samples are submitted to DHEC. Many of these tests are simple procedures and could be performed by high school students.

121

STUDENT OBJECTIVES

The student will be able to:

Conduct tests for water quality and quantity, such as pH, dissolved oxygen, turbidity, water flow.

Describe microscopic appearance of drinking water.

STUDENT ACTIVITIES

Use sand, clay, or soil to make a model of the watershed. Cover the model with tinfoil. Construct a rain bottle (jar with holes in lid). Sprinkle water over model, discuss and determine the rates and direction of water flow. The model may be altered to illustrate possible changes and may be used for other activities in this unit.

Visit a local watershed and use activity card F, p. 61.

If testing kits are not available, construct a depth and temperature finder, secchi disk, sampler. Conduct water sediment test. Collect water samples from various sources. Fold a paper towel to form a cone in a funnel. Pour each sample through a separate cone. Save the filtrate. Allow the paper towel to dry. Observe and record.

Examine drinking water and discuss quality of drinking water.

Measure water criteria of a stream. Work in small groups on the activity cards A and B, p. 62.

RESOURCES

S. C. River Map. Maps are available from S. C. Land Resources Commission, 2221 Devine St., Columbia, S. C. 29205

Slide Set: "Watershed Conservation & Development in S. C.," S. C. Land Resources Commission. Publication: Let's Grow Community Benefits from Watershed Projects.

S. C. Land Resources.

Publication: What is a Watershed? USDA Soil Conservation Service, P. A. 420.

Article: "Remember Clean Water?" National Wildlife, December-January 1977.

A Drop to Drink. Office of Public Affairs EPA, Washington, D. C.

Activity Card: Standard Methods. American Public Health Association, Inc., New York.

122

CONTENT

STUDENT OBJECTIVES

The student will be able to:

Predict pH, temperature
dissolved O_2 of a stream,
using the list of aquatic
animals found.

STUDENT ACTIVITIES

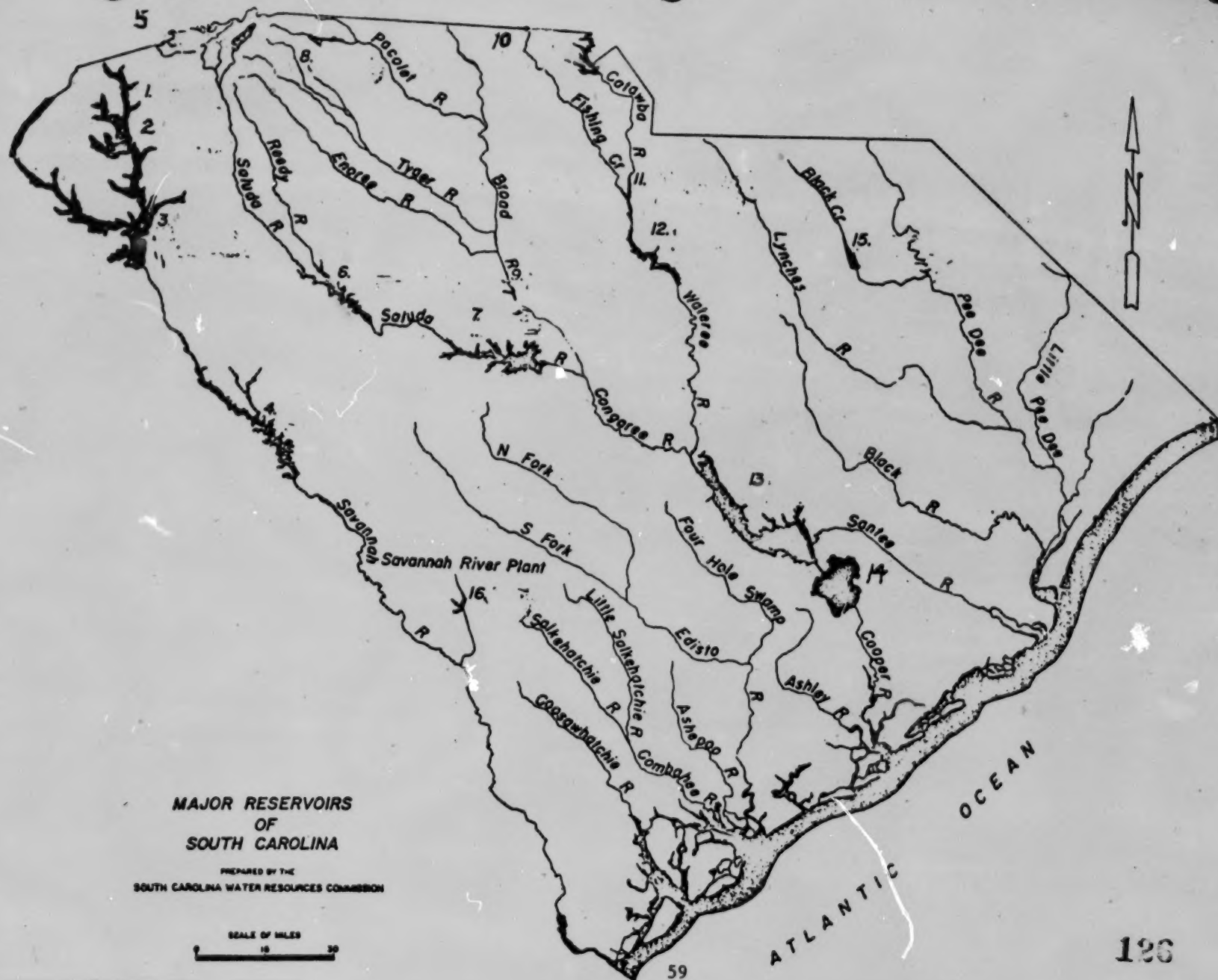
Establish a water testing center
to report to the S. C. Health
and Environmental Control on a
regular basis.

Predict, using activity cards
C and D. Discuss. Page 64-65.

RESOURCES

For information on
establishing center, write
to: S. C. Health and
Environmental Control,
Mr. Robert King, 2600 Bull
Street, Columbia, S. C.

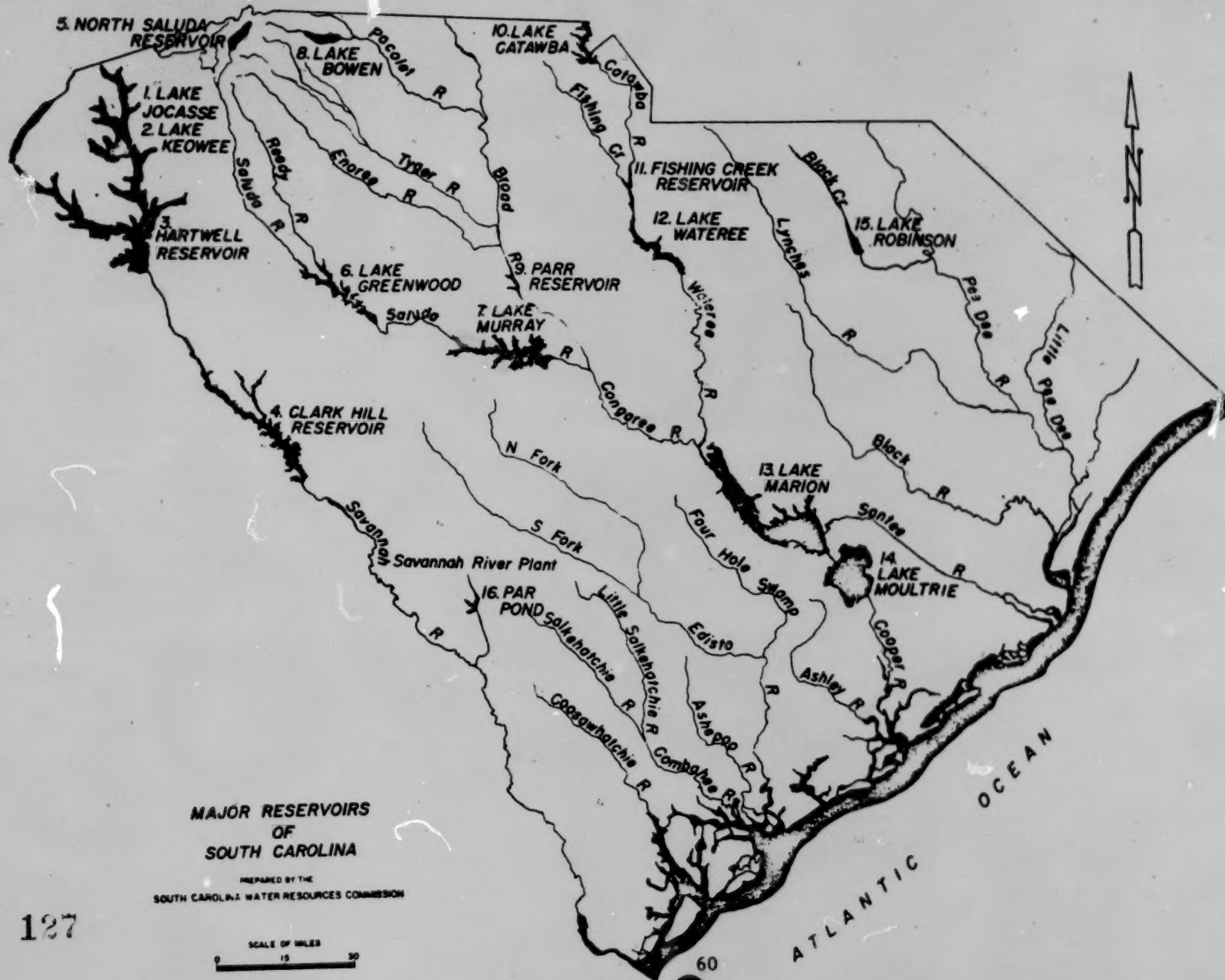
For construction of
equipment see pp. 101-103.



MAJOR RESERVOIRS OF SOUTH CAROLINA

PREPARED BY THE
SOUTH CAROLINA WATER RESOURCES COMMISSION

SCALE OF MILES
0 10 20 30



TASK F (small groups)

Describe what you think a watershed is. _____

Find your location on this stream (pond, lake) on the map.

Where does the water come from? _____

Where does it go? _____

Draw lines around the boundaries of our watershed. We are in the _____ watershed.

What activities in this watershed might change the characteristics of this water?

Activity	Ways the activity might change the characteristics of the water

Questions and Discussion

1. "What activities did you list and how did you think they would change the water characteristics?"
2. "Are any of these evident here?"
3. "How would we find out more about this watershed?"

ACTIVITY CARDS

Front

TASK A (individuals or small groups)

As you approach the water, observe and record your observations.

Plants _____

Animals _____

Air _____

Rocks _____

Water _____

Other _____

TASK B (individuals or groups)

Part 1

Using a collecting equipment (screens, jelly cups, etc.), collect as many types of aquatic animals as possible. Put them in the white dishpans for observation by the group. (Keep the pans in a cool place.) When you have finished, move on to Part 2 of the task. Try to identify the aquatic life found.

Part 2

Using the "Golden Nature Guide Pond Life" books, or similar field manuals, and picture keys on the other side of this card, generally identify the specimens you found.

List or sketch the animals you found. Return animals to water as soon as you have finished.

Description of where found	Type (name or sketch)	How many	Common name

Back

Questions and Discussion

1. "What do you notice about the water environment?"
2. "What are some factors that affect the lives of animals in water?"
3. "Where would you expect to find animals in a water environment?"
4. "What are some guidelines that we need to consider in collecting aquatic life so our investigation will cause the least impact on the environment?"

(p. 66)

Questions and Discussion

1. "What animals did you find?" (You might compile a group list, preferably on a chart.)
2. "Where did you find most of the specimens?"
3. "What other life would you expect to find in this stream?"
4. "What are some things we could do with this list of animals?"

132

TASK C (Individuals)

On the basis of the aquatic animals you found, the tables in the Aquatic Data section below, and your observations, predict the following characteristics of this stream.

I predict that the:

Water temperature will be _____ because _____

Air temperature will be _____ because _____

pH will be _____ because _____

Dissolved O₂ count will be _____ because _____

I can see about _____ ft. into the water.

The color of the water is _____.

Keep these predictions for future use.

AQUATIC DATA

Table I. pH Ranges That Support Aquatic Life

	MOST ACID					NEUTRAL					MOST ALKALINE			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Bacteria	1.0												13.0	
Plants														
Algae, rooted, etc.						6.5							12.0	
Carp, suckers, catfish, some insects						6.0			9.0					
Bass, crappie						6.5		8.5						
Snails, clams, mussels							7.0		9.0					
Largest variety of animals (trout, mayfly, stonefly, caddisfly)						6.5		7.5						

Table II. Dissolved Oxygen Requirements for Native Fish and Other Aquatic Life

Examples of Life	O ₂ in parts per million or milligrams per liter
Cold-water organisms, including salmon and trout (below 68° F.) Spawning, growth and well-being (caddisfly, stonefly, mayfly)	6 ppm and above
Warm-water organisms (including game fish such as bass, crappie, cat fish and carp) (above 68° F.) Growth and well-being (some caddisfly)	5 ppm and above

Table III. Temperature Ranges (Approximate) Required for Certain Organisms

Temperature (Fahrenheit)	Examples of life
Greater than 68° F. (20° C) – warm water	Much plant life, many fish diseases Most bass, crappie, bluegill, carp, catfish, caddisfly
Middle range: 55° - 68° F. (12.8° - 20° C)	Some plant life, some fish diseases Salmon, trout, stonefly, mayfly, caddisfly, water beetles
Low range: Less than 55° F. (12.8° C) – cold	Trout, caddisfly, stonefly, mayfly

DATA CARD

Table I. Relationships of water color to productivity

The quantity of life that may be present in any given body of water at any given time is often referred to as the "productivity." A water of low productivity is a poor water, biologically speaking, but is a clean water and desirable as a water supply or for recreational use. A productive water may be either a nuisance to man or it may be highly desirable. Foul odors and weed-choked waterways are usually branded a nuisance, however, bumper crops of bass, catfish or sunfish may be the result and are highly desirable.

Color of Water	Probable Cause	Fish Food Productivity
Clear	Absence of algae and microorganisms	Low
Greenish Hue	Blue green algae	Moderate
Yellow to Yellow-Brown	Diatoms (microscopic, one-celled algae)	Moderately High
Red	Micro-crustaceans	High
Dark Brown	Peat, Humus	Low

GEOLOGICAL FACTORS HAVING BEARING ON COLOR

In limestone geology: Green	Abundant Calcium	Moderate
In volcanic geology: Yellow-Green Red	Abundant Sulfur Abundant Iron	Low Moderate

Table II. Relationship of Water Clarity to Fish Food Production and Watershed Condition

Depth you can see into water (secchi disk reading)	Interpretations of Depth Readings		
	Fish Food Production (If reasons for degree of clarity are biological (algae, etc.))	Condition of Watershed above Water Readings (If reasons for degree of clarity are physical (soil situation, etc.))	Possibility of Dissolved Minerals
0' - 6" (0-15.2 cm)	Most productive waters for fish food Maximum oxygen from photosynthesis (greatest diurnal variation) Maximum algae growth	Poor condition due to soil runoff, slides, etc.	Most
• 24" (• 61.0 cm)	Least productive for fish food Minimum oxygen from photosynthesis (least diurnal variation) Minimum algae growth	May indicate better condition because of vegetation cover - more stable soil, etc.	Least

Table III. Temperature Layering in Ponds-Lakes

In summer, the surface water absorbs the sun's heat and warms faster than the water below. The warmed water is lighter than the cold water, so it floats on the cool layers. By midsummer there are three distinct layers.

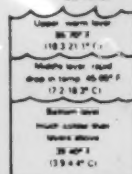
During the summer, mixing or circulation is prevented by these stratified layers of water which act as a barrier.

The upper layer of water cools in autumn until it approaches the temperature of the water in the middle and lower layers. Aided by winds, the surface water sinks causing circulation from top to bottom.

In winter, the cold surface water continues to sink and the water becomes stagnated, photosynthesis slows, and oxygen levels drop.

In the spring, aided by winds, another circulation and mixing occurs, called the "Spring Overturn."

Seasonal Change Diagram
Summer



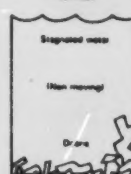
During the summer, fish and aquatic life are most active.

Spring and Fall



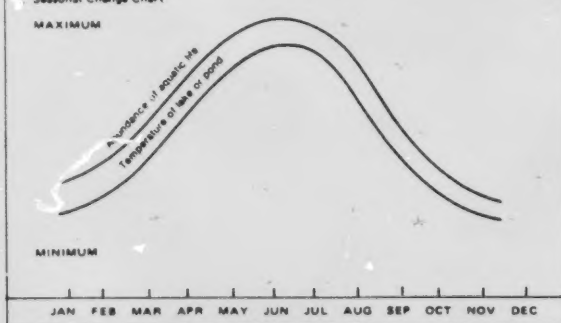
During spring and fall overtures, the temperature of the water is equalized throughout the lake. Fishes and other animals are more active than in winter, but less active than in summer.

Winter



Activity is greatly reduced during the winter. Many animals hibernate in the mud or debris at the bottom.

Seasonal Change Chart



TASK D (grades 3-5)

Make Sure Everyone in Your Group Gets Involved in the Testing.

1. Using the water test kit, determine the water and air temperature, dissolved oxygen count, and pH of the stream or pond.
Record the data below, using predictions from Task C.

Name of Stream, Pond or Lake:

Location of water sample (edge or middle of stream bank of pond, etc.)	Time Taken	Temperature (°F or °C)				pH		Usable Oxygen (ppm) (mg/liter)	
		Water		Air					
		My pred.	Actual test	My pred.	Actual test	My pred.	Actual test	My pred.	Actual test

2. Water Productivity and Color

On the basis of the color you recorded in Task C and Table I (See Data Card reverse side), what can you say about this water?

3. Light Penetration (pond or lake)

My estimate of how far I could see into water (from Task C) is _____ ft. (or meters).

Transparency of lake and pond waters can be roughly determined by the use of a white and black plate (called a secchi disk), which is lowered on a line until it can no longer be seen. It is approximately 8 inches in diameter, painted white and black in alternative quadrants. Verify the sunlight penetrates below the point at which the disk disappears.

Lower the Secchi disk into the water until it can no longer be seen. Measure depth from surface of the water to the disk and record _____ ft. (or meters).

On the basis of the depth of the Secchi disk and Table II, what can you say about the water?

4. Temperature Layering (pond or lake)

On the basis of the temperatures you recorded for your pond, the season of year, and the information in Table III, describe what you think is happening in the water now.

SOME SUB-SURFACE FRESH WATER ORGANISMS



BRYOZOAN
COLONY

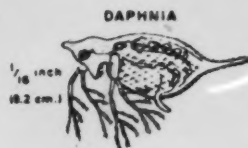


LEECH



FRESH WATER
SHRIMP

FAIRY SHRIMP 1 inch (2.5 cm.)



DAPHNIA



CYCLOPS

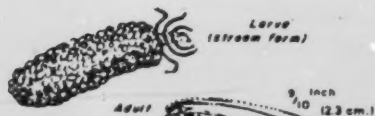


PLANARIA

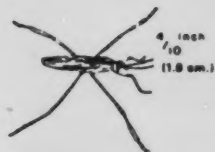
SOME AQUATIC INSECTS



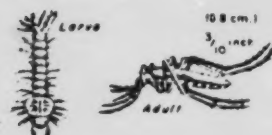
MAYFLY



CADDISFLY



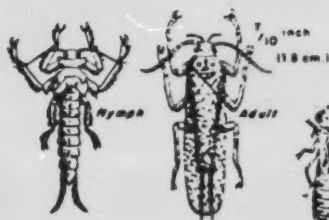
WATER STRIDER



MOSQUITO



WHIRLIGIG BEETLE



STONEFLY



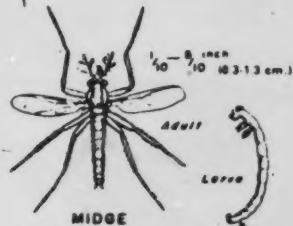
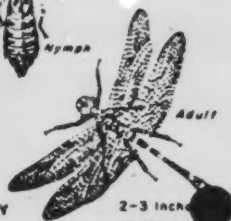
CRANEFLY



BLACK FLY



DRAGONFLY



MIDGE

CONTENT

Waterborne bacteria and viruses were causes of sickness and death at the turn of the century in the U. S., but there are still problems with these and other waterborne diseases in other parts of the world.

State and federal legislation has been passed and is continually updated to ensure quality water.

STUDENT OBJECTIVES

The student will be able to:

Identify some waterborne diseases.

Describe the 1972 law identifying water quality problems. Explain the importance of the 208 law to the local community.

STUDENT ACTIVITIES

Report on waterborne diseases that you contract when visiting other countries. (Ex. diarrhea, typhoid, cholera, etc.)

Report on water related diseases.

Invite a speaker to talk on the "Quality of Drinking Water." Contact District Environmental Quality Control Office for information. Distribute publication: A Drop to Drink. If your speaker represents EQC, ask him to bring some publications.

Invite a speaker to talk on the Safe Drinking Water Act and EPA, state and local regulations.

Read about the 208 law. Comment on how local water measures up to these laws. Explain tests used to kill bacteria, destroy tastes and odors, and remove impurities.

RESOURCES

Resources for Environmental Education. A Drop to Drink, p. 92-93.

CONTENT

Non-point water pollution comes from runoff, air pollution fallout, stripmining, and construction activities. Because it is so diffuse, it is much more difficult to find and fight, than specifically pin-pointed discharges.

Industrial discharges are being curtailed and some rivers are better, but municipal efforts are not adequate for clean water.

Kepone is just one of the poisonous pesticides and toxic substances contaminating the waters in the U. S.

Nuclear plants are increasing in number. Because of this, the danger of nuclear accidents resulting in waste discharge into lakes and streams exists.

STUDENT OBJECTIVES

The student will be able to:

Define non-point water pollution and find evidence of this type of pollution in the local community.

Describe legislation to control non-point water pollution and explain how it could affect you directly and indirectly. How could it affect development of shopping centers, etc.?

Describe the effects of toxic substance in water on people.

Identify the impact of nuclear pollution upon humans in surrounding areas.

Describe the types of nuclear waste pollutants.

Explain the probability of waste contamination and its effects on water life.

Describe the safeguards taken by nuclear agencies and plants.

STUDENT ACTIVITIES

Interview a member of the local Soil Conservation Service concerning non-point water pollution. Interview the Regional Council of Governments Planning Office personnel concerning non-point source water pollution.

Stage a mock public hearing concerning the 208 legislation and its impact on the individual (see page 81-83).

Review and report on kepone affair and other water pollutants. (Ex. PCB, DDT, etc.)

Discuss: "Cancer costs the American people over \$15 billion annually." Some small fraction of that total, perhaps \$2 or \$3 billion each year, must be spent by the federal government to find out how chronic exposure to water and air pollution affects human and environmental health.

Ask a speaker from a nuclear plant to describe possible pollutants.

RESOURCES

See also pp. 95-100.

CONTENT

Water resources are used in countless ways; for domestic use, for agriculture uses, for transportation, for recreation, for industry, and for energy. Count on your fingers the ways you've used water today. Overwhelming, isn't it?

STUDENT OBJECTIVES

The student will be able to:

Describe individual and family water uses.

STUDENT ACTIVITIES

Locate on a map sites of nuclear related industry in S. C.

Identify the check-points that each industry uses for safeguard and mark them on a map.

Check on nuclear incidents in S. C. and their results, including their effect on water quality.

Describe nuclear waste disposal methodology in the U. S. and its impact on humans.

Calculate the amount of water falling on the county annually (information available from weather bureau). Calculate the consumption of water based on population (information available from county development board).

Construct a collage or collages of water conservation or proper use.

RESOURCES

Free: Booklet, Toward Cleaner Water, EPA.

Water Conservation, S. C. Water Resources.

Reference: U. S. News and World Report, July 18, 1977, "Is U. S. Running Out of H₂O?"

CONTENT

Industry: It takes 100 gallons of water to make one Sunday newspaper, 650 gallons to make steel for one bicycle.

Farming: 75 gallons of irrigation water to grow one ear of corn.

Recreation: Lakes for fishing and swimming.

Domestic: It is estimated that each of us uses 100 gallons of water every day. With 2.6 million people in S. C., that means our personal requirement averages 260 million gallons of water everyday. Once used, this amount in most instances must be "cleaned up" before it can be returned to a lake, stream, or other basin of water.

Here are some ways we use water in S. C.:

flush a toilet	6 gals.
tub bath	30-60 gals.
shower bath	10 gals./min.
dishwater	16 gals./fill
washing machine	30-40 gals./load

STUDENT OBJECTIVES

The student will be able to:

Describe uses of water for food and food cultivation.

Describe water recreation activities in S. C. Locate major water recreational areas in S. C.

List household uses of water and recognize how much water is used at home.

STUDENT ACTIVITIES

Prepare a report on irrigation systems used in S. C. to grow foods.

Find out and report on the kinds of foods that come from water. (Ex. fish, clams, etc.)

On a map of S. C. locate the major water recreational areas. (Ex. canoe trails, lakes, etc.)

Chart water use for one day for yourself and your family, page 71.

RESOURCES

Water Conservation,
S. C. Water Resources.

Make a list of all the ways that you use water. Draw a chart like the one below and carry it with you for a day. Mark it each time you use the water. Estimate the approximate total of water you use in one day. How much do you use in a year?

Water Use	Av. Amt. for 1 Use	Your Use: ✓ Each Time Used	Total Per Day
A drink of water	$\frac{1}{2}$ gal.	(Ex: ✓✓✓✓)	$(4 \times \frac{1}{2} = 1)$
Washing hands	2 gal.		
Flushing a toilet	6 gal.		
Shower	10 gal./min.		
Tub bath	30-60 gal.		
(Add others)	and estimate amount used)		
Total for 1 day			

Resource list:

McDonalds
National Wildlife EQ Index

Some water is used for the total family. A few examples and estimates are listed below. Add other uses in your home and estimate total used for the family. If each member of your family used as much water for personal use as you do, what is the total of all water used by your family per day?

Family Use	Av. Amt. for 1 Use	Times Used Per Day	Total
Clothes washer	30-40 gal./load		
Cook meal	5 gal.		
Wash dishes	8 gal.		
Dishwasher	16 gal.		
Others:			

CONTENT

A faucet dripping at the rate of one drop per second equals four gallons of water wasted each day. This is a total of 1,460 gal. of water wasted a year. If this water enters a waste treatment system, there are 1,460 gal. more to be treated. Both systems require energy. Have you checked your faucets lately?

A leaking toilet, losing $1\frac{1}{2}$ gal. an hour, loses 13,000 gal. of water a year, or enough to flush a toilet 2,400 more times. Have you checked your toilets lately?

"The question that now occurs is, how much water do we waste? With a little thought and a few easy steps, we can conserve large amounts of water, and in the process, reduce sewage flows as well as the amount of wastes discharged to the environment. Lowering the amount of energy flows will save money and energy since less sewage will have to be processed. Therefore, conserving water saves us money by reducing;

1. water, pumpage and treatment
2. energy, to move it
3. waste treatment bills.

STUDENT OBJECTIVES

The student will be able to:

Recognize water waste and describe ways to conserve water.

STUDENT ACTIVITIES

Make a collage illustrating water waste.

Construct a county map showing major water pollution areas (rivers, lakes, and sources). Discuss the economic impact and effect on people in the county.

Name 5 ways S.C. rivers are being misused and propose a plan which would alleviate each problem.

Determine the volume of water in streams and number of people it could serve, activity card E.

RESOURCES

Programmed Learning Aid for Introduction to Environmental Science, Phillip W. Foster and Roger H. Hermanson, Learning Systems Co., Homewood, Illinois 60430, \$3.50
Publication: A Primer on Waste Water Treatment, S.C. Dept. of Health & Environmental Control, 2600 Bull St. Columbia, S.C. 29201

TASK E (in groups)

Part 1. For Stream

Instructions for collecting and recording streamflow measurements.

(For metric application, substitute meters for feet and liters for gallons.)

1. Measure and mark a 100-foot distance along a straight section of your stream. If you can't find a 100' section, use 25' or 50'. Throw a stick (5 or 6 inches long, or 12.7 or 15.2 cm long) in the water above the upstream marker. Record the number of seconds it takes to float downstream between the markers. Record below. Now divide the 100-foot distance by the total seconds it took the stick to float between the stakes. Do this three times and use the average time.

$$\begin{array}{rcl} \text{1st measurement} & 100 \text{ ft} & \div \text{Total seconds} = \text{ft. per second} \\ & \text{(distance)} & \text{(total seconds)} \quad \text{(number of feet stick} \\ & & \text{to float 100 ft.)} \quad \text{floated each second)} \end{array}$$

$$\text{2nd measurement } 100 \text{ ft} \div \text{Total seconds} = \text{ft. per second}$$

$$\text{3rd measurement } 100 \text{ ft} \div \text{Total seconds} = \text{ft. per second}$$

$$\text{Total } \text{ft. per second} \div 3 = \text{ft. per second (average)}$$

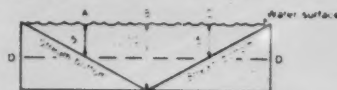
2. Find the average width of your section of the stream. Measure the width of the stream at three places within the 100-foot area, then divide the total by three to get the average width of the stream.

$$\begin{array}{rcl} \text{First measurement} & \text{ft.} & \\ \text{Second measurement} & \text{ft.} & \\ \text{Third measurement} & \text{ft.} & \\ \text{Total} & \text{ft.} & \div 3 = \text{ft. (average width)} \end{array}$$

3. Find the average depth of your section of the stream. Measure the depth of the stream in three places across the stream in a straight line, then divide the total by four to get the average depth of the stream.

$$\begin{array}{rcl} \text{First measurement} & \text{ft.} & \\ \text{Second measurement} & \text{ft.} & \\ \text{Third measurement} & \text{ft.} & \\ \text{Total} & \text{ft.} & \div 4 = \text{ft. (average depth)} \end{array}$$

NOTE: The reason you take three depth measurements then divide by four is to take into account the shallow areas of the stream. It can be explained by the following example of a drawing of a stream cross section. If depth in three places is A(3'), B(10'), and C(5'), (total 20'), find an average by dividing by three, $20' \div 3 = 6.23'$. Now look at the area or average depth (D), which is 5'. Take total of depths and divide by four: $20' \div 4 = 5'$, the correct average depth.



4. Find the cubic feet of water per second. Multiply the average width, average depth, and the number of feet the stick floated each second. (A cubic foot is water in a container 1 foot wide, 1 foot high, and 1 foot long, or 7.48 gallons. A cubic meter of water is the amount in a container 1 meter wide, 1 meter high, and 1 meter long, or 1,000 liters.)

$$\begin{array}{rcl} \text{Average width} & \text{ft.} & \times \text{Average depth} & \text{ft.} & \times \text{Number of feet per second} & = \text{Cubic feet of water flowing per second} \end{array}$$

5. The average person uses about 200 gallons (757 liters) of water a day for home use. (This does not reflect each person's share of water used for public services and industrial and commercial uses.) In order to find out how many people could get the water needs for 1 day from this stream, complete the following calculations.

$$\begin{array}{rcl} \text{Stream flow in cu. ft. per second} & \times & \text{Gallons in 1 cu. ft. of water} & = & \text{Gallons of water per second} \end{array}$$

$$\begin{array}{rcl} \text{Gallons per second} & \times & \text{Seconds in minute} & = & \text{Gallons of water per minute} \end{array}$$

$$\begin{array}{rcl} \text{Gallons of water per minute} & \times & \text{Number of minutes in a day} & = & \text{Total gallons water per day} & \div & \text{200 Gals. (Amount of water one person uses per day)} & = & \text{Total number of people who could get daily water needs from this stream} \end{array}$$

MEASURING WATER VOLUMES FOR STREAM, POND, OR LAKE

(For a stream, use Part 1; for a pond or lake, use Part 2.)

Part 1. Stream Measurements

Questions and Discussion

1. "How many people do you think could live off the water in this stream (domestic water use only)?"
2. "What measurements do we need to know in order to determine the amount of water in this stream?" Discuss how to make different measurements. Work Task E, Part 1.

Questions and Discussion

1. "How many people could live for 1 day (domestic use only) off the water in this stream?"
2. "How did your prediction compare with your measurement?"
3. "What would happen to this environment if we piped all the water at this point to a community?"
4. "If we were going to use some of this water, how much should be left to flow downstream? Why?"
5. "What might affect the amount of water in this stream?"
6. "How important is this stream to a community? To the environment here?"

Part 2. Pond or Lake Measurements

Questions and Discussion

1. "How many people do you think could live off the water in this pond or lake?" (domestic water use only)
2. "What measurements do we need to know in order to determine the volume?" Work Task E, Part 2.

Questions and Discussion

1. "How many people could live for one day (domestic use only) off the water in this pond?"
2. "How did your prediction compare with your computations?"
3. "What might affect the amount of water in this pond?"
4. "What would happen to this aquatic environment if we drained it?"
5. "If we were going to use some of this water, how much should be left to minimize damage to the pond environment?"
6. "How important is this pond to the environment?"

TASK E, (in groups)

Part 2. For Pond or Lake

Instructions for collecting and recording volumes of water in a pond or lake.

(For metric application, substitute meters for feet and liters for gallons.)

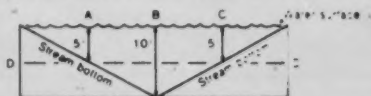
1. Find the average diameter (distance across) of the pond. Measure the length and width of the pond. You may have to take several length and width measurements and get average of them.

Pond width _____ ft.
 Pond length _____ ft.
 Total _____ ft. $\div 2 =$ _____ ft. (average diameter)
 Average diameter _____ ft. $\times 3.14 (\pi) =$ _____ sq. ft. surface.
 (area of pond)

2. Find the average depth of the pond or lake. Measure the depth in three places along a line (transect) across the pond, as near the middle as possible. Add these depths and divide by four (see explanation below) to get the average depth. (If additional accuracy is desired, repeat this process along additional transects and average results.)

First measurement _____ ft.
 Second measurement _____ ft.
 Third measurement _____ ft.
 Total _____ ft. $\div 4 =$ _____ ft. (average depth)

NOTE: The reason you take three depth measurements then divide by four is to take into account the shallow areas of the stream. It can be explained by the following example of a drawing of a stream cross-section. If depth in three places is A(5'), B(10') and C(5'), (total 20'), find an average by dividing by three: $20' \div 3 = 6 \frac{2}{3}'$. Now look at the area or average depth (D) which is 5'. Take total of depths and divide by four: $20' \div 4 = 5'$, the correct average depth.



3. Formula for computing number of gallons of water in pond.

a. $\frac{\text{Area of pond}}{\text{Average depth}} \times \frac{\text{Volume in cu. ft.}}{\text{Volume in cu. ft.}} = \frac{\text{Volume in cu. ft.}}{\text{Volume in cu. ft.}}$
 b. $\frac{\text{Volume in cu. ft.}}{\text{Volume in cu. ft.}} \times 7.48 = \frac{\text{Number of gals. water in pond}}{\text{Number of gals. water in pond}}$

(A cubic foot of water is the water in a container 1 foot wide, 1 foot high, and 1 foot long, 7.48 gallons. A cubic meter of water is the amount in a container 1 meter wide, 1 meter high and 1 meter long, or 1,000 liters.)

4. Formula for computing the volume using acre feet of water. (Two meter equivalent included)

a. $\frac{\text{Area of pond in feet}}{\text{Average depth in feet}} \times \frac{\text{Volume cu. ft.}}{\text{Volume cu. ft.}} = \frac{\text{Volume cu. ft.}}{\text{Volume cu. ft.}}$
 b. $\frac{\text{Volume cu. ft.}}{\text{Volume cu. ft.}} \div \frac{43,560}{\text{sq. ft. in an acre}} = \frac{\text{acre feet of water.}}{\text{acre feet of water.}}$
 c. $\frac{\text{Acre feet}}{\text{Gal./acre foot}} \times \frac{395,900}{\text{Number of gallons in pond}} = \frac{\text{Number of gallons in pond}}{\text{Number of gallons in pond}}$

5. The average person uses about 200 gallons (757 liters) of water a day for home use. (This does not reflect each person's share of water used for public services and industrial and commercial uses.)^{*} In order to find out how many people could get their water needs for 1 day from this pond, complete the following calculations.

$\frac{\text{Gallons of water in the pond}}{\text{Amount of water one person uses per day}} = \frac{\text{Total number of people who could get daily water needs from this pond}}{\text{Total number of people who could get daily water needs from this pond}}$

CONTENT

The ecological approach indicates that we move beyond the narrow output control approach of waste treatment plants and think in terms of reclamation plants. Tomorrow's word is recycle.

STUDENT OBJECTIVES

The student will be able to:

- Describe methods of waste treatment.
- Identify methods of recycling waste.
- Observe the filtering of muddy water by charcoal and sand.

Distinguish between primary, secondary, and tertiary methods of waste treatments.

Identify the use of septic tanks.

STUDENT ACTIVITIES

SEWAGE TREATMENT

Obtain a dime-store flour sifter or make a container with a screen bottom. Cover the screening with a layer of absorbent cotton, next a 1" layer of fine sand, a 1" layer of coarse sand, and then a 1" layer of gravel. Set the sifter over a jar and slowly pour muddy water into it. Does the water look clean when it comes out the bottom? While the water may look clean, it still contains germs and should not be drunk! Compare what you did in this experiment with the way sewage or wastes are treated in regular treatment plants.

Class project in which a plug of cotton is placed in a flower pot, add layers of sand and charcoal. Pour muddy water into the pot, allowing it to drain into a glass jar. Write a sentence describing appearance. Collect, read to class, and discuss. Follow experiments with reports on water treatment, primary, secondary and advanced treatment.

Read and report on publication, A Primer on Wastewater Treatment.

Take a field trip to a local water plant or sewage lagoon.

Determine and report on waste recycling in your community, state, or in the nation.

RESOURCES

flour sifter
cotton
sand
gravel
water
jar

"Ranger Rick,"
National Wildlife.

Publication: A Primer on Wastewater Treatment, Environmental Protection Agency, Washington, D.C.

See page 84-86.

CONTENT

Water constantly moves in a cycle, whether in a primitive forest or a bustling city.

STUDENT OBJECTIVES

The student will be able to:

Describe how local sewage is treated.

Trace water through the cycle, use and waste treatment.

STUDENT ACTIVITIES

Investigate regulations on septic tank construction and location.

Trace a drop of water from a water cycle to home, factory, farm sewage treatment, and reenter water cycle. Student report on "What Is 208."

Adopt a stream.

Conduct hidden work, crossword puzzle tests, page 87-91.

RESOURCES

12 Steps to Cleaner H₂O.

REFERENCES

1. A Citizen's Guide to Clean Water, Izaak Walton League of America, Regional EPA office.
2. Action for Environmental Quality: Standard and Enforcement for Water and Air Pollution Control (free), Office of Public Affairs, Washington, D.C. 20460, EPA.
3. Citizen Action Can Get Results, available at EPA regional office for 20¢.
4. Concepts in Environmental Education, S.C. Wildlife & Marine Resources Department, Bimonthly publication (free), P. O. Box 176, Columbia, S.C. 29202.
5. Coon, Herbert L., and Charles L. Price. Water-Related Teaching Activities, Columbus, Ohio: ERIC Center for Science, Mathematics, and Environmental Education, The Ohio State University, 1977.
6. Culler, John. "Water...Our Most Talented Resource," S.C. Wildlife, volume 18, no. 2, March-April, 1971.
7. Don't Leave It All To The Experts, available at EPA regional office for 55¢.
8. Forest Service, U.S. Department of Agriculture. Teaching Materials for Environmental Education, Investigating Your Environment. U.S. Forest Service, Washington, D.C., 1977.
9. For information of physical inventory of lakes, including maps, for each county, see report #119. Inventory of Lakes in South Carolina, Ten Acres or More in Surface Area. S.C. Water Resources Commission, 700 Knox Abbot Drive, Cayce, S.C. 29033.
10. National Wildlife EQ Index, 1977, Educational Series, National Wildlife Road, 1412 16th Street, Washington, D.C. 20036, for 25¢.
11. Palmetto Waters, S.C. Water Resources Commission, 3330 Forest Drive, P.O. Box 4515, Columbia, S.C.
12. Preserving Man's Environment, Pavoni, Hagerty, and Heer, 1971 Data Courier, 620 South Fifth, Louisville, Ky. 20202.
13. Public Participation Handbook For Water Quality Management, available at EPA regional office (free).
14. Water, Yearbook of Agriculture, 1955, U.S. Department of Agriculture, Superintendent of Documents, Washington, D.C.
15. Wildlife Week, 1977 Ideas For Teachers, National Wildlife Federation.

WATER. . . OUR MOST TALENTED RESOURCE

By: John Culler

The talents of water are almost endless. It is the life-blood of plant and animal alike. It cools our motors, washes our faces, waters our lawn, and floats our boats. It generates our electricity, cleans our dishes, washes our clothes, and carries away our wastes. We drink it, catch fish out of it, blow bubbles in it, and get it on the knee. It cools our drinks in the summer and warms our homes in the winter. Without water we wouldn't have trains, airplanes or newspapers. It even falls out of the sky in four varieties.

Because water is so talented and lends itself to so many tasks, we have found so many ways to use it that we have created a crisis. Before long there won't be enough good water to go around. In coming years the old battle over the water hole will be re-enacted many times, only this time on a much larger scale, with the fate of many more people hanging in the balance.

Fortunately for every living thing, there is a lot of water on the earth, and fortunately for South Carolina, we are a wet state. Once I heard a U.S. senator explain the reason why the Southeastern United States was growing so fast individually. "It's because of our water," he said. "We have something all other sections of the country would like to have, but can't get. Abundant rainfall."

The average annual rainfall in the United States varies greatly from region to region. The wet season on the west coast is in winter, but over most of the rest of the country the warmer months are the rainy ones. The amount of rainfall varies from a minimum average of near nine inches per year for Nevada to over 56 inches per year for Louisiana. In South Carolina, the average annual rainfall is 48 inches, with the most rain coming in July and the least in November. South Carolina is one of the wettest states. An adequate rainfall is one of our greatest blessings, because an abundant water supply is literally a matter of life or death for every form of plant or animal life. Some very simple organisms can live without air, but none without water.

If he had to, man could probably live on a gallon of water a day for drinking, cooking and washing, but it would be tough. In medieval times man probably used no more than three to five gallons a day, and in the 19th Century, especially in western nations, he was using about 95 gallons a day. At present in the United States man uses about 1,500 gallons a day for his needs and comforts including recreation, cooling, food production, and industrial supply.

The average home uses 60 to 70 gallons a day. It takes three gallons to wash dinner dishes by hand, but twice that amount by machine. It takes two gallons of water to flush garbage down the drain, five gallons a minute to take a shower.

It takes 1,000 gallons of water to produce one quart of milk, and a single corn plant consumes 50 gallons of water in a growing season. Even the human body is 65 percent water. In his lifetime, a man living to the age of 70 will require a minimum of one-and-a-half million gallons of water.

While the earth's water supply is fairly constant and we are not losing water, we do have a limited amount, especially fresh water. Ninety-seven percent of all the water on earth is salt water, and almost ninety-eight percent of the remaining water is tied up in polar ice caps. This means that less than one percent is useable fresh water, and this is being reduced. George Borgstrom of Michigan State University says Americans are removing twice as much from groundwater reserves as is being returned.

Ground water, our underground reservoirs, contain more fresh water than all of our surface reservoirs and lakes. It has been estimated that we have enough ground water to equal 10 years of average rainfall or 30 years of average runoff. About 18 percent of all the water Americans use comes from ground water, but water tables have dropped in many places because this water, just as Borgstrom says, is being used faster than it is being replaced by the water cycle.

The big jump in water usage has come with industrial growth. For instance, one large paper mill will use as much water as any of our biggest cities in the South. It takes 500 gallons of water to manufacture one yard of woolen cloth; 320,000 gallons to make a ton of aluminum; half a million gallons to make a ton of synthetic rubber. It takes 100,000 gallons of water to produce one automobile, 1,400 gallons to make \$1 worth of steel. In fact, man's industrial progress can be traced by charting his utilization of his water resources. Without an adequate supply of good water virtually no industry can survive.

The predicted demand for water in this country in 1980 will be 600 billion gallons a day whereas the available supply is estimated to be only 515 billion gallons a day--a deficit of 85 billion gallons per day. By the year 2000, we will be using a trillion gallons of water a day.

Water users in South Carolina now withdraw water from wells, lakes, streams, and rivers in amounts more than 800 million gallons per day. By the year 2000, these users are anticipated to withdraw nearly three times this volume! Much of the water now withdrawn is used and returned to its source as waste water, reduced in quality, to be drawn out and used again by downstream agricultural operations, municipalities and industries. This cycle is repeated numerous times as the water flows from the mountains to the sea. The quality of the water becomes less and less, with the result that the water is less and less fit for reuse, while demands for water along its course to the sea are further increased.

Of 15 rivers basins studied for a water inventory by the South Carolina Water Resources Commission recently, all 15 basins were projected to have increases in municipal water requirements in the next 10 years, and 14 of these will be an increased demand for industrial water. Percentages of municipal water use range from a 16 percent gain for the Lynches River Basin to a 134 percent increase in the areas served by the Great Pee Dee Basin.

In these study basins, seventy-four percent of the water used is by industry, while municipalities used the other 26 percent. Industrial and municipal water use has increased 105 percent in South Carolina since 1960, while the projected figures for 1980 shows a 48 percent increase over what was used in 1970. This does not include any new industrial users that may move into these areas.

During the next ten years, according to the Water Resources Commission, South Carolina will experience unprecedented growth in new water users, thus greatly increasing the estimated 1980 water use figure.

The solution to the water problem, not only in South Carolina, but in the nation, is clear. We can not get more water, so we must reuse what we have. Water is a reusable resource, and is not "used up" in the sense that other natural resources are, but when water is used without care and wisdom, the final effect is still the same.

American industries withdraw over 17 trillion gallons of water per year from ground and surface sources but treat less than five trillion gallons to remove pollutants before discharging it into the public's waters. This 17 trillion gallons is about 50 percent of the nation's total water use.

To deposit clean water back into streams after use is expensive. Primary-secondary water treatment, which removes up to 90 percent of the pollutants, costs 12 cents per 1,000 gallons. Tertiary treatment--necessary if we want our water really pure--raises the cost to 30 cents per 1,000 gallons.

And demand continues to skyrocket. According to the National Wildlife Federation, by 1980 nuclear power plants alone will require one-eighth of the total stream flow in the United States for cooling--emphasizing again the need to reuse available water whenever possible.

There are a few bright spots in the picture, however small. For instance, it takes only half as much water now to make a ton of paper as it did in 1949. And desalting plants, the dream of scientists ever since it was discovered the sea is salty, are finally becoming an economic reality. The cost of producing 1,000 gallons of fresh water from sea water has been reduced from more than \$4 in 1952 to 85 cents today, and desalting costs are expected to continue to drop. Sometime after 1980 desalted water may be used for irrigation of high-value crops.

Experts predict within 20 years desalting plants at critical spots will be producing 500 million gallons a day, enough to supply the largest cities. In these plants, sea water is boiled off and the salt is left behind.

However, at the risk of a bad pun, these efforts will be just a drop in the old bucket. If we are to meet our water demands in South Carolina in coming years, we must treat water for what it is, a reuseable resource.

Both the Water Resources Commission, which does the planning for the future, and the South Carolina Pollution Control Authority, the agency in charge of enforcing water quality standards, have vitally important roles to play in the future of South Carolina.

South Carolina Wildlife

164

WHAT IS 208?

by Dave Whitney

SOS Program Director

The year of the citizen is at hand in water pollution control. Government programs related to the Federal Water Pollution Control Act Amendments of 1972 are dangling the brass ring of citizen participation directly in front of us and well within our reach. If we, as interested citizens, fail to grasp the "208" ring, there may never again be such an open opportunity for us to express our concerns about what is done to solve our water quality problems.

The designation "208" simply refers to Section 208 of the FWPCA of 1972. This section of the law calls for identifying water quality problems and finding solutions to those problems on a local level by fostering cooperation among local governments, public agencies and interested citizens. By more common designation, Section 208 is known as that portion of the Federal law which deals with areawide waste treatment management planning.

The most important thing to remember about 208 is the word MANAGEMENT as opposed to studying. There are five major elements in 208 which have been left out or given only cursory treatment in past water quality studies. These make 208 unique in its approach to solving water quality problems. They are all-inclusive, forming the most comprehensive approach to water quality planning to date. They include:

1. A regional approach.
2. The relationship between land use and water quality.
3. Non-point sources of pollution.
4. The emphasis on the implementation of plans.
5. Public participation.

While most studies of the past have included one or two of these elements, never before has the government attempted to bring together such a comprehensive approach as 208 in one single package, and particularly at the planning stage. We, as interested citizens, are being asked to get in on the ground floor, bring our interests into the basic construction to serve in an accountable capacity for the implementation of a 208 plan.

In actual practice, 208 planning areas are designated by the governors of the respective states based on the needs of areas within those states. Once a 208 designation has been made, either an existing agency within the state, or a newly-formed one for the express purpose of administering the 208 plan, is designated as the areawide planning body.

There are some good informational materials available to those interested in getting involved in the 208 process. First, and possibly foremost, as a basic text in learning about the FWPCA of 1972, is the booklet

A Citizen's Guide to Clean Water, produced by the Izaak Walton League of America in conjunction with the U.S. Environmental Protection Agency. A second excellent publication is the Public Participation Handbook for Water Quality Management. Both these books are available free from the regional EPA offices.

In addition, EPA, 208 agencies, and the regional offices have copies of a 10-minute film titled "Speak Up" with an accompanying booklet. These can provide the ideal kickoff to direct involvement in the 208 process.

As we start our basic education in 208, let's take a brief look at the five elements we have already outlined, and possibly suggest some areas that may require special study in preparing ourselves for participation in the water quality management process.

First, the concept of a regional approach is an attempt to recognize the economic and geographic reality of the relationships which exist in the major metropolitan centers of a state. Watershed boundaries and political boundaries rarely coincide. Basically, planning regions are bodies without souls. They simply exist by definition and have no institutional reality. Despite these problems, however, the regional approach may be beneficial because it requires us to find coordinated and politically acceptable solutions in areas that share the same water.

Land use is always a significant element in water quality management, yet land-use control is the most jealously guarded prerogative of local governments. The basic fact remains that water quality is almost always determined by land use, either directly or indirectly, yet encroachment on local authorities land-use policies generate tough battles in almost all cases.

Non-point sources of water pollution such as agricultural and urban area run-off have been grossly neglected in the perpetuation of water quality management programs to date. Only in the past couple of years have the water experts begun to carry out extensive research into the cause and effects of non-point source water pollution. Such things as fertilizers, salt and pesticides which run off the land have only hazily been recognized in the past as contributing to water pollution problems. Non-point sources have generally been difficult to quantify, and even today identification and quantification of non-point sources are the real problems we must deal with in areawide programs.

Planned management and implementation calls for giving from many sources that have heretofore been in more or less absolute control of their so called empires. Sharing across political boundaries, giving up politically-oriented authorities, raises many territorial questions that we must learn to work out without adding a myriad of new institutions and hierarchical structures. Effective areawide management demands common sense cooperation, not necessarily more institutions to carry it out.

And, last but foremost, public participation has for the most part been a sometime thing in water pollution control programming. Usually it has been limited to public hearings, the value of which has depended upon the local administrators of water pollution control programs. The 208 approach calls for a very positive effort to solicit public participation. Pragmatically, public participation entails reaction to and criticism of specific proposals. We must take part in the 208 process by proving input in the beginning.

The real question posed by the 208 process is whether or not we, as interested citizens, are up to the task at hand. We must prepare ourselves well enough to become involved in open dialogue with everyone concerned in the areawide management concept. We must trade a portion of our previous provincialism for the broader concept of the areawide process.

"208" is a concept to problem solving that may be bigger than any of us, individually or collectively. It is one that is the current law of the land, and one with which we must familiarize ourselves and prepare to become an active part of before we lose this brilliant opportunity to have an active role in the water quality management process.

208 INFORMATION COUPON

For more information on how you as citizens can participate in the 208 process in your own communities, clip this coupon and mail to:

"208", EPA, Public Information Center (PM-215),
Washington, DC 20460.

NAME _____
ADDRESS _____
CITY _____ STATE _____ ZIP _____

A summary written by S.C. Department of Health and Environmental Control for teachers.

WASTE TREATMENT MANAGEMENT PLANNING

The nation's concern for the condition of its waters and its strong commitment to abate water pollution are expressed in the Federal Water Pollution Control Act Amendments of 1972.

The Amendments, perhaps the most comprehensive program ever undertaken to clean up the nation's waters, mandates a sweeping effort to prevent, reduce and eliminate water pollution. It sets six goals:

1. To eliminate the discharge of pollutants to navigable waters by 1985.
2. To provide water quality which protects and fosters propagation of fish, shellfish, and wildlife and allows recreation in and on water by 1983.
3. To prohibit discharge of toxic pollutants in toxic amounts.
4. To provide financial assistance to construct publicly owned treatment systems.
5. To develop and implement areawide waste treatment management plans.
6. To develop technology necessary to carry out these goals.

The goals set the stage for a coordinated series of specific actions which must be taken with strict deadlines and strong enforcement provisions by federal, state, and local governments.

The Act recognized the rights of the states to prevent and eliminate pollution within their borders and to plan the development of land and water resources. Full public participation was encouraged in the development and revision of any regulations, plans and programs. Responsibility for administering the Act was given to the Administrator of the U.S. Environmental Protection Agency (EPA).

Waste treatment management planning is authorized under Section 208 of the amendments (i.e. 208 planning). 208 planning is viewed as an opportunity and a tool to create an environmental management system which will encourage close examination of environmental interrelationships and permit wiser control decisions than were previously possible.

208 planning is a comprehensive management program for the collection and treatment of wastes and the control of pollution from all point and non-point sources (non-point sources are all those which do not emanate from a single outlet: examples are runoff from agriculture and forestry operations and salt water intrusion into ground waters).

A. Local Facility Management

Section 208 is perhaps the most comprehensive program Congress has established under the Federal Water Pollution Control Act Amendments of 1972. The program can tie together the various water pollution control and abatement requirements, including those for municipal, industrial, and residual wastes, as well as runoff

and groundwater pollution control. The law places the responsibility for developing and carrying out solutions to these problems with state and local governments. Under Section 208, geographic areas with significant water quality problems are singled out for areawide planning. An agency of local governments is selected by the governor to do the planning. EPA then provides funding to develop a comprehensive program to control municipal and industrial wastewater, storm and sewer runoff, non-point source pollution, and land use as it relates to water quality. A state must perform the 208 planning in all nondesignated areas within its borders and must coordinate its planning with that going on in the designated areas.

Section 208 provides the only authority under federal law to control non-point source pollution. This type of pollution, which enters the water through diffuse means, such as stormwater runoff or sedimentation, is a difficult problem. Because solutions are not always obvious or easy to perfect, more innovative approaches will be required than for any other aspect of the act. While EPA will do research and provide technical assistance to 208 planning agencies, the answers to non-point source problems must be tailored to each region by each 208 agency.

The majority of the 208 plans will be submitted during 1978; all initial plans must be submitted to EPA for approval no later than November 1, 1978. A 208 plan should be oriented toward achieving state water quality standards and must be updated annually through the state continuing planning process. The contents may vary geographically, but all must address the items listed below in some detail:

1. Population, household, and economic projections for a 20-year period.
2. A summary of present land uses (residential, commercial, and industrial) within the planning area.
3. A classification of all streams and other navigable waters into two types of segments: effluent-limited segments, which meet state water quality standards now or which will meet them after limiting the amount of pollutant discharges on the basis of uniform national requirements; and water-quality-limited segments, which will not meet applicable state water quality standards even with nationally based discharge limitation. For the latter type, the state water pollution control agency, under Section 303 of the law, will establish more stringent requirements on allowable pollution.
4. An inventory of pollution from all point sources--such as municipal and industrial waste treatment outlets--and from non-point sources, such as erosion caused by stormwater and agricultural runoff. Non-point source control will be necessary in most areas to meet the law's goals; in some areas, in fact, non-point sources are the major water polluters.
5. Identification of new and expanded municipal sewage treatment plants necessary to handle the area's wastes for the next 20 years and meet the state water quality standards.
6. Identification of methods to keep sludge from polluting both surface waters and groundwater.
7. Identification of new and improved stormwater for urban and industrial runoff problems, with special emphasis on land management controls (on-site detention storage, for example, would receive more emphasis than, say, the construction of new pipes and conduits for off-site treatment).
8. Identification of all regulatory programs and land use measures to control non-point pollution, and as assessment of the time required to achieve the desired results. These programs and measures would include zoning, subdivision regulations, floodplain regulations, and performance standards.

9. Identification of public agencies with the administrative, legal, and financial capabilities to construct, operate, and maintain treatment facilities or to implement the regulatory programs on non-point sources. These are the agencies that will be responsible for actually implementing the 208 plan.
10. As assessment of the social, environmental, and economic aspects of the plan.

To date, 176 areawide agencies have been designated. These agencies have jurisdiction over areas containing about 50 percent of the population of the United States and 15 percent of the land area. EPA provides 75 to 100 percent grants for planning, and thus far has obligated \$216 million; an additional \$137 million is tied up in litigation, but EPA has requested a supplemental budget appropriation for \$69 million. By the end of 1982, the federal government may have provided a total of \$500 million as its share of 208 grants. About 170 professional staff members are assigned to the regional offices and the rest are in Washington.

The 208 program was viewed by Congress as a coordinating mechanism for other sections of the act. After November 1978, all construction grants under Section 201 must go through 208 agencies, and all National Pollutant Discharge Elimination System (NPDES) permits under Section 402 must be consistent with 208 plans.

B. Non-Point Pollution Control

Another main thrust of the 208 planning effort will be to develop Best Management Practice (BMP's) for the control of non-point source pollution. This 208 plan is being prepared on a statewide basis by the Department of Health and Environmental Control. The department will develop a non-point source management program with the assistance of state and federal resource agencies. The non-point source BMP's will be implemented by state and local agencies that will be identified in the planning process.

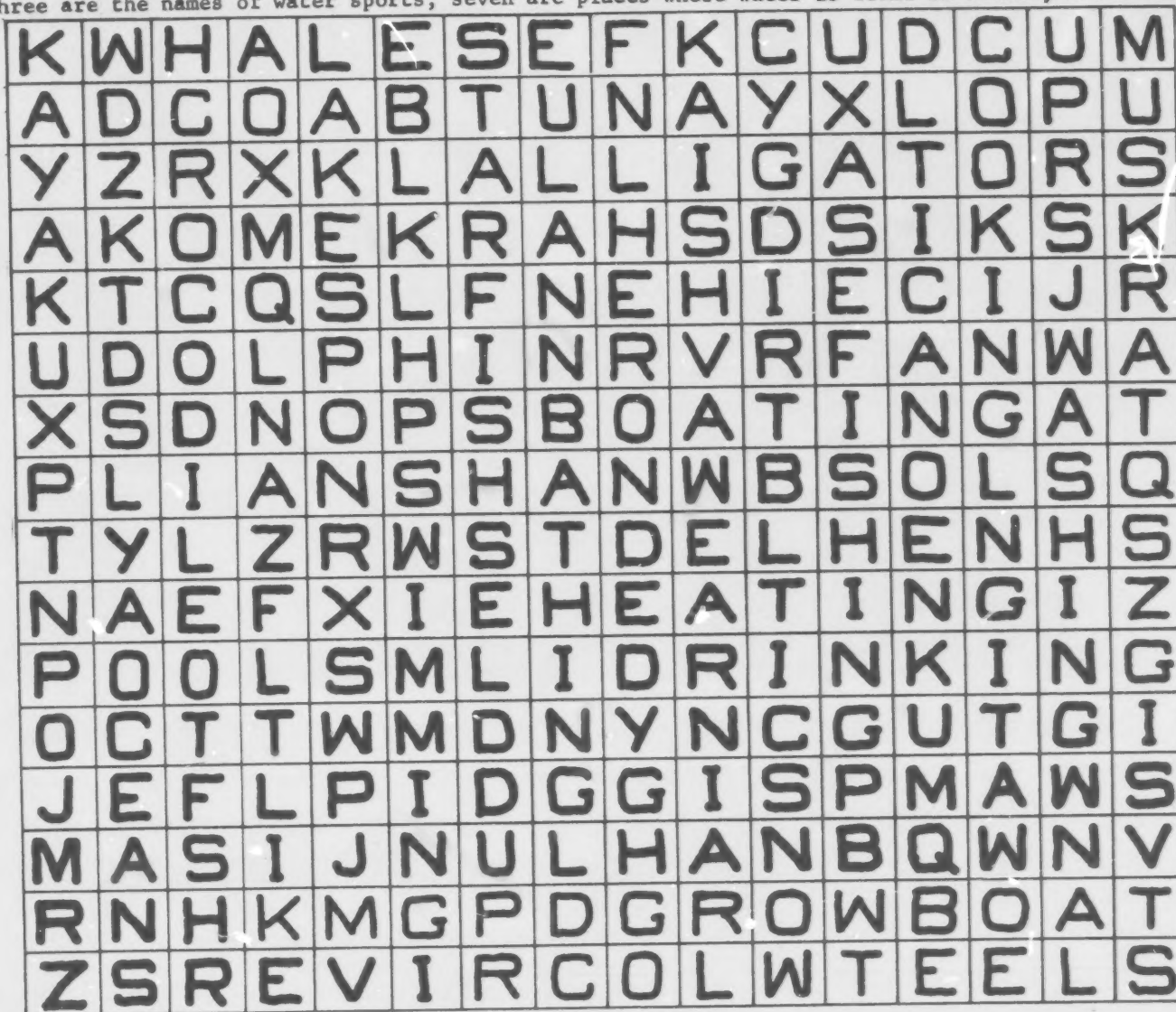
The implementation of the BMP's for non-point pollution control will be directed by the management agencies on a voluntary basis. In as much as this will be a new program, there is at present no State law enabling enforcement of non-point BMP's. The possibility of a problem with implementation will be addressed in the planning process. Several implementation alternatives will be considered.

The primary issue will be to develop implementable voluntary non-point BMP's. To do this we will need the support and acceptance of the affected publics. To gain support and acceptance we will have to involve the public in development of the alternative BMP's. This involvement will be beyond the scope of traditional public participation. The affected public will have to understand the issue and be able to evaluate the alternatives before they can fully participate.

Point at Issue -- Will non-point BMP's be accepted and implemented on a voluntary basis?

HIDDEN WORDS ASSOCIATED WITH WATER

See if you can find 37 words, hidden in this puzzle, that are associated with water. They are from three to nine letters long. They may read up, down, sideways, diagonally, forward or backward. Five are the names of animals found in the ocean, six of animals found in wetlands. Five of them are ways that water is used in the home. Three are the names of water sports, seven are places where water is found in nature, seven others are

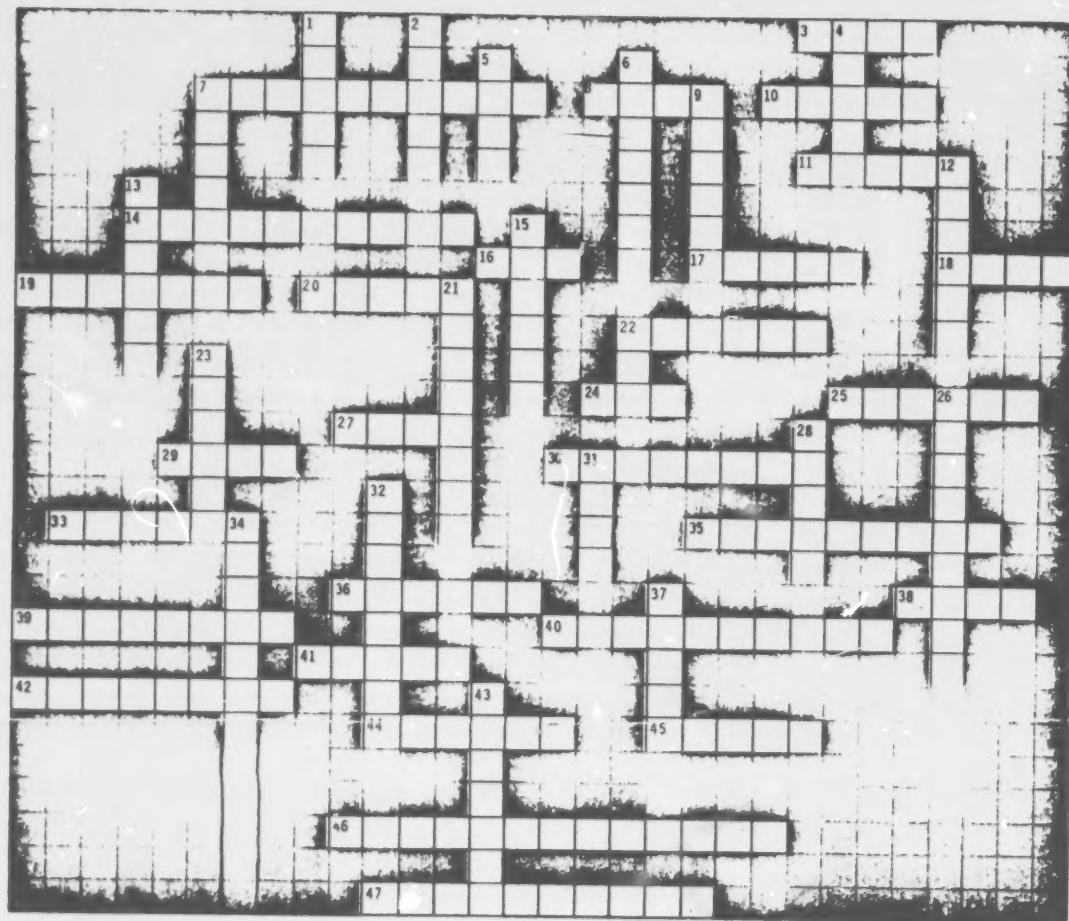


ways to travel on water, and four are forms of precipitation.

Wildlife Week, 1977, Ideas for Teachers, National Wildlife Week.

These word games are used with permission from the National Wildlife Federation.

1977
WATCH
FOR



ON
THE
HORIZON



3. The world's water is _____ over and over again.
7. A _____ is 97% water.
8. _____ can be removed from sea water in several ways known as desalination processes.
10. Two percent of all fresh water is frozen in the _____ ice caps.
11. The sun evaporates water which forms into clouds and rains down. This unending process is called the water or hydrological _____.
14. Without _____ many crops would fail.
16. An acre of corn gives off 4,000 gallons of water per _____.
17. Towns often store water in tall _____.
18. Widespread drought in the 1930's produced the _____ bowl. (Rhymes with "rust.")
19. Lack of rain for a long period of time is a _____.
20. Water _____ is an important source of electricity.
22. In the U.S., rainfall averages annually from 7 to 135 _____ in different regions.
24. If all the world's ice were to melt, the _____ level everywhere would rise about 500 feet.
25. An adult requires at least $2\frac{1}{2}$ _____ of water daily.
27. Only _____ of the world's land gets enough rain.
29. Large amounts of minerals in water can make it _____. (Opposite of "soft.")
30. Water for people is purified with chemicals like _____.
33. Big _____ usually get their water supply from rivers or lakes.
35. _____ of water is a serious problem in the U.S., Canada, and most other countries.
36. Heavy rain or melting snow can cause _____.
38. Heat pollution of water used by industry for cooling can kill _____.
39. To fight tooth decay, _____ is added to water in many communities.
40. _____ applied to crops and washed into streams or lakes often results in water pollution.
41. Over 80% of human _____ is water. (Rhymes with "mud.")
42. The goal of federal law by 1983: all waterways clean enough to protect wildlife and permit _____ and other recreation.
44. A water faucet which leaks a drop of water every _____ wastes 4 gallons a day. (Part of a minute.)
45. If all mountains and valleys were leveled, water two _____ deep would cover the earth. (Track stars can run one of these in less than 4 minutes.)
46. The federal _____ Protection Agency and the states are working together to solve water pollution problems.
47. The goal of federal law by 1985: no more _____ discharged into our water.



1. Most of the world's water is found in the _____.
2. Only about 3% of the earth's water is _____.
4. The sea is _____.
5. Two-thirds of your _____ is water.
6. A bath takes about 35 _____ of water.
7. You can't live without it.
9. A person who drinks only sea water will die of _____.
12. Flowing water _____ the soil. (Rhymes with "loads.")
13. A shower bath uses at least 5 gallons of water each _____.
15. Water erosion created the spectacular Grand _____.
21. "Precipitation" means _____, snow, sleet, etc.
22. Frozen water is _____.
23. Most water used in homes is for _____ disposal.
26. Even in a water-rich nation like the U.S., _____ of water is sometimes necessary. (Rhymes with "fashioning.")
28. Towns often rely on _____ for their water. (Rhymes with "yells.")
31. Oceans store great amounts of _____ in summer, helping to keep the climate more mild. (Rhymes with "neat.")
32. America spends _____ of dollars annually to treat its waste water, but many problems still remain.
34. Man can make rain by _____ clouds. (Rhymes with "breeding.")
37. Boiling water creates _____ which can be used to run machines.
43. Water purity is the objective of the Federal Water Pollution _____ Act. (Rhymes with "patrol.")

ANSWERS TO HIDDEN WORDS PUZZLE AND CROSSWORD PUZZLE

Ocean animals: whale, shark, starfish, tuna, and dolphin. Wetlands animals: heron, duck, alligator, crocodile, snail, and muskrat. Water uses: drinking, washing, cooking, bathing, and heating. Water sports: swimming, boating, and fishing. Where to find water: lakes, ponds, pools, puddles, rivers, oceans, and swamps. Water travel ways: rowboat, canoe, ship, skis, kayak, raft, and tug. Precipitation: ice, snow, sleet, and rain.

ACROSS: 3. used, 7. watermelon, 8. salt, 10. polar, 11. cycle, 14. irrigation, 16. day, 17. tanks, 18. dust, 19. drought, 20. power, 22. inches, 24. sea, 25. quarts, 27. half, 29. hard, 30. chlorine, 33. cities, 35. pollution, 36. floods, 38. fish, 39. fluoride, 40. fertilizer, 41. blood, 42. swimming, 44. second, 45. miles, 46. Environmental, 47. pollutants.

DOWN: 1. ocean, 2. fresh, 4. salty, 5. body, 6. gallons, 7. water, 9. thirst, 12. erodes, 13. minute, 15. Canyon, 21. rainfall, 22. ice, 23. sewage, 26. rationing, 31. heat, 32. billions, 34. seeding, 37. steam, 43. Control.

Is Your Drinking Water Safe?

United States Environmental Protection Agency, Office of Public Affairs, Washington, D.C. 20460,
A Drop to Drink. A report on the quality of our drinking water, revised March 1977.

An adult American consumes from one and a half to five or more quarts of water a day depending on climate, the kind of work performed, body size, and many other factors.

Most of us assume that the water we drink is safe. It usually is, but some people are using water that is improperly treated and may be contaminated by bacteria, toxic chemicals, metals, or other pollutants.

At least 4,000 known cases of waterborne illnesses occur each year in this country. The actual total may be ten times greater. Further, medical science has not yet determined the effects on people of long-term, low-level exposure to contaminated drinking water.

To combat this threat to our health, Congress enacted the Safe Drinking Water Act, which was signed by the President on December 16, 1974. The Act marks the first time a truly national commitment has been made to safeguard public drinking water supplies. It provides that the Federal Government--the U.S. Environmental Protection Agency (EPA)--set national standards for drinking water, and that the states enforce those standards and otherwise supervise public water supply systems.

This booklet describes the state of the Nation's drinking water and explains how the Act will help to protect your drinking water supplies.

When EPA was created on December 2, 1970, it was given the responsibility for enforcing federal drinking water standards. In recent years widespread evidence has been found of problems in drinking water supplies across the nation. Here are some examples:

1. In the period of 1961-1973, there were more than 200 known or reported outbreaks of disease or poisoning caused by contaminated drinking water. Twenty-two people died and an estimated 54,537 became ill, many seriously. Some EPA water supply experts believe that perhaps ten times as many such outbreaks occur but go unreported for a variety of reasons, and that countless individual sufferers--and their doctors--fail to associate ailments with contaminated water. Germ-laden drinking water can cause salmonellosis and gastroenteritis, both serious illnesses involving the stomach and intestines, as well as typhoid and cholera.
2. Based on a 1969 Community Water Supply Study, an estimated eight million people were being served potentially dangerous water from perhaps 5,000 community water supply systems.

Principal findings of the study, which actually evaluated 969 community water supply systems:

56 percent of the systems showed problems in equipment design, construction, or condition of the basic water treatment plants;

77 percent of the plant operators were not trained well enough in water microbiology, and 46 percent lacked proper knowledge of the chemistry related to their jobs;

79 percent of the systems had not been inspected by state or county authorities in the year before the study began;

Overall, small systems were found to have more problems than larger ones. These findings were supported by later U.S. government studies.

3. Studies begun in 1970 of public water supply systems in 13 states showed that many systems did not meet bacteria standards one or more months during the 12-month period before the studies were made.

Numerous systems also did not meet bacteria surveillance standards and others needed either additional treatment facilities or important changes in their operation. The studies for all 13 states recommended major increases in budgets of the state water supply supervisory agencies to protect public health.

4. In 1975, a survey by EPA of public water supplies in 80 cities found that small quantities of organic chemicals were present in the systems in all parts of the country. Although the survey found them in very low concentrations in the water, their presence was cause for concern.

In addition to these studies, scientists warn that new contaminants are degrading water. The use of chemical compounds in industry, homes, and on farms has increased sharply in the last several decades. There are thousands in use today. New chemicals are developed each year and many of these can enter and contaminate both surface and underground water. In large amounts some of the chemicals found in drinking water could cause cancer, genetic mutations, or birth deformities.

Chemical contaminants, such as certain pesticides, detergents, metals, radioactive substances, and solvents are all products of our advanced industrial society and are potential threats to our water sources.

Most conventional treatment plants, originally built to produce water from less-polluted sources, may not be effective in the removal of increasing amounts and varieties of these chemical contaminants, trace metals and radioactive materials.

EPA water supply investigators also are concerned about viruses in drinking water, because of deficiencies in the operation of water supply treatment facilities and distribution systems. Infectious hepatitis, for example, an illness of the liver, is caused by a virus that may find its way into water supplies.

A General Review of the Situation

There are more than 50,000 community water supply systems in this country and more than 200,000 water supply systems serving locations such as restaurants and motels. Many of them were not designed to cope with their present raw water quality. These systems were designed, primarily, to remove from the relatively clean water of earlier days the type of bacteria found in animals and people. The principal concerns at that time were typhoid, cholera, and dysentery. The risk of contracting the first two of these diseases now has been greatly reduced in the United States, thanks to better protection and management of our drinking water supplies. In the year 1900, for example, there were 35,379 deaths reported from typhoid fever. By comparison, in 1975 there were approximately 375 cases of typhoid reported, and of course this was in a U.S. population nearly three times that of the year 1900. In fact, the improvement of public water supplies has been the largest single factor in the dramatic decline of typhoid.

Federal standards for drinking water were first issued in 1914 to prevent the interstate spread of communicable diseases, and were modified and expanded several times thereafter. In 1962, the U.S. Public Health Service revised its drinking water standards. The standards set mandatory limits for health-related chemical and biological impurities, and recommended limits for impurities affecting appearance, taste and odor. Although these standards applied only to water supply systems serving interstate carriers such as trains, planes and buses, most states and large cities used them as guidelines to regulate drinking water quality within their jurisdictions.

When EPA was established in December 1970, it assumed responsibility for setting and enforcing federal drinking water regulations, and continued a revision--already in progress--of the 1962 U.S. Public Health Service standards. This revision served as the basis for the interim primary regulations developed under the 1974 Safe Drinking Water Act.

The 1974 Act was designed to assure that water supply systems serving the public meet minimum national standards for protection of public health.

The Act gives EPA responsibility for setting minimum national drinking water regulations for all public water systems throughout the United States having at least 15 service connections or regularly serving at least 25 people. The states are to play the lead role in enforcing these regulations. If a state is negligent in administering the law, however, EPA may take action. The Agency also may act to prevent or halt drinking water contamination posing an "imminent and substantial" health hazard if state and local authorities fail to respond.

If public water systems cannot reasonably meet the regulations, provision is made for state to grant variances and exemptions but these must not pose unreasonable risk to public health and a schedule must be established for compliance. A public hearing must be held before any public water system is granted such a schedule.

The drinking water regulations in the Act are of two types: primary and secondary. Primary regulations are aimed at protecting public health, taking cost into consideration. The 1975 regulations establish maximum allowable contaminant levels in drinking water. Future regulations may include water treatment techniques and general criteria for water supply system operation, maintenance, siting, and intake water quality. Secondary regulations are designed to protect public welfare, and deal with taste, odor, and appearance of drinking water.

On December 24, 1975, interim primary regulations were published by EPA, as required by the Act, to help safeguard the nation's public drinking water supplies. The regulations, effective June 24, 1977, apply to about 250,000 public water systems. In brief, the interim regulations set maximum contaminant levels permitted for bacteria, maximum turbidity of water and levels permitted for number of organic and inorganic chemicals. They also set the minimum number of times drinking water systems must be sampled for adherence to the regulations.

In the meantime, the National Academy of Sciences is conducting a study on the health effects of drinking water contaminants. The report will form the basis of revised primary regulations--scheduled to be proposed in 1977 and to become effective in 1979.

If a public water supply system fails to comply with the primary regulations or fails to meet a compliance schedule established under a variance or exemption granted by a state, it must give notice of this failure to its customers and the news media.

The Act also provides for regulating the underground injection of fluid to prevent the endangerment of underground sources of drinking water. This is accomplished by means of a regulatory program similar to that governing public water systems. Primary responsibility falls to the states where underground source protection programs have been established. If a state has failed to assume this responsibility within two years after enactment, EPA will prescribe a control program for that state.

The Act specifies that regulations will not be established that will interfere with oil or natural gas production, unless such regulations are considered essential to ensure that underground drinking water sources will not be endangered by such injection.

Other highlights of the Act:

1. EPA is authorized to conduct research on technological and health aspects of providing drinking water. Special studies required by Congress include a rural water survey, and research into the contamination of drinking water by waste disposal, viruses, and cancer-causing chemicals. Work in these and other research areas is underway.
2. EPA is also authorized to help states improve their drinking water programs by providing technical assistance, employee training, and financial support.
3. Provision is made for assuring adequate supplies of treatment chemicals for public water supply systems.
4. A citizen may bring civil action against any public water system or federal agency (including EPA) that he or she believes is violating the Act.
5. A 15-member National Drinking Water Advisory Council is established to advise EPA on proper implementation of the legislation. The general public, state and local agencies, and interested private organizations are represented on the Council.
6. The Department of Health, Education, and Welfare, which oversees the safety of bottled drinking water, is required to make such water conform to the primary standards set under the Act, or publish reasons for not doing so.
7. To help EPA implement the legislation, Congress authorized \$156 million for each of the fiscal years 1975, 1976 and 1977.

Water supply research is essential to provide the scientific information necessary to support all levels of government in working for safe and esthetically acceptable drinking water.

EPA research, for example, is developing techniques to make possible monitoring for viruses in drinking water. The association of viruses with hepatitis and other diseases is well known, but analytical methods for viruses have been difficult and expensive.

EPA is investigating the degree to which minimum chlorination and other types of disinfection of drinking water eliminate viruses along with bacteria. Viruses are not removed from water supplies unless treatment systems are operating properly. Much more research is needed on this potentially critical problem. Work also is required to develop effective methods to protect our water sources from new toxic chemicals and from radioactive wastes.

In addition, recent national surveys have demonstrated the widespread occurrence of chloroform and related compounds in the drinking water of utilities practicing chlorination. Chloroform has been shown to cause cancer in rats and mice under certain conditions. Research efforts have demonstrated that chloroform production can be greatly reduced by avoiding chlorination prior to clarification, or by removing certain organic chemicals by filtration through granular activated carbon. This type of carbon also is effective for removing many other undesirable organics from water.

EPA's water supply research is primarily directed to:

1. Investigations of waterborne diseases to determine relationships between drinking water quality and disease in communities. This research includes determination of the acute and long-range chronic effects on people of organic and inorganic chemicals that may be found in drinking water. Many of the thousands of different toxic chemicals in industrial use today find their way into water sources. The studies seek to determine safe tolerance limits of these chemicals in drinking water.
2. Development of simple, rapid methods for detection and measurement of bacteria, chemicals, and toxic agents in water.
3. Development of improved water treatment processes.

The Safe Drinking Water Act will provide much of the funds necessary to maintain EPA's initiative in drinking water supply research.

Treatment

The quality of source waters generally will determine the treatment processes required to produce safe, acceptable drinking water.

Most surface waters are subject to temporary deterioration in quality through increased levels of turbidity, algae growths, and various contaminants. To be on the safe side, surface waters should receive more than simple disinfection. Treatment could include collecting solids, allowing them to settle out, filtering the water, or a combination of these methods.

If waters are too contaminated for treatment by such processes, they will require non-conventional and perhaps newly developed methods. In addition, great care should be taken to prevent and control contamination of the raw-water source.

Disinfection is the minimum recommended treatment for groundwater used in public water supply systems. Over the years, drinking water from protected wells has been delivered to customers without any treatment. However, contamination of such distribution systems together with related outbreaks of disease have demonstrated the need for adding a disinfectant such as chlorine when necessary.

Individual homes use ground water from springs and wells; these serve some 30 million Americans. In addition, about 80 million people are served by community systems that draw upon groundwater. Water from deep wells is often acceptable but problems due to geology can arise. Infectious hepatitis and typhoid fever from contaminated shallow wells have been reported in some areas. Such pollution may be caused by seepage from septic tanks or contaminated surface waters.

The Federal Water Pollution Control Act of 1972 proclaims two general goals for the United States:

1. Wherever possible by July 1, 1983, water that is clean enough for swimming and other recreational use, and clean enough for the protection and propagation of fish, shellfish, and wildlife.
2. And then, by 1985, no more discharges whatsoever of pollutants into the nation's waters.

Obviously, the improvement of surface waters under the 1972 Act will make it easier to provide safe drinking water, since discharges into streams and lakes ultimately affect sources of public water systems. However, surface water will still require treatment before it is used in water supply systems. Sediments must be removed and the water filtered, taste and odor controlled, and disinfectant added because of the possibility of human error and the introduction of contaminants. The water supply treatment plant is the last barrier between the consumer and impure water.

An estimated 50 percent of the nation is served by drinking water from surface sources, some of which receive industrial waste, untreated sewage, urban runoff, and effluent from sewage treatment plants. Health officials have relied on storage and treatment of this water to protect the public against infectious diseases and toxic substances.

Safeguards must be provided to prevent the introduction of untreated or inadequately treated wastes into drinking water systems. One such safeguard would involve some system of stream storage or holding and dilution reservoirs between the reclamation plant and the drinking water intake. Biological and chemical monitoring of stored waters is essential.

Removal of salt from water could provide many areas of the country with new drinking water sources. Such desalination is now employed in many parts of the world. However, it is expensive because of related fuel and construction costs. It is used in certain areas, including parts of Florida, Oklahoma, Arizona, California, and in the American Virgin Islands, where shipping or piping in fresh water would be even more costly.

An Informed Citizenry

Citizen awareness and participation is an important part of the national effort in maintaining pure drinking water. There are several ways in which you can take part in the public process.

First, you should familiarize yourself with the Safe Drinking Water Act, EPA, and state and local regulations governing drinking water. Then find out how your water measures up, including the adequacy of future supplies, treatment and testing procedures, standards of purity, and current research.

Examine testing records. Is your supplier testing as frequently as regulations require? Is the water tested for all contaminants cited in the regulations?

If you are dependent upon individual water supplies, has your well or cistern been inspected and have samples from these sources been tested by your local or county health department?

If your drinking water has an unpleasant taste, odor, or appearance, contact the water utility for an explanation. If the answer is not satisfactory, call or write your state health or environmental protection department, since these agencies deal with "aesthetic" factors in drinking water.

However, if you suspect the water is actually unsafe, you should immediately call the same authorities--the water utilities and state agency overseeing water systems--and demand an explanation. If the answers are unacceptable, contact your nearest EPA office.

The Safe Drinking Water Act of 1974 requires every public water system to notify customers of any failure of the system to comply with requirements of the primary drinking regulations. This includes any instance when the system receives a variance or exemption from requirements. Such notification usually must be given every three months in newspapers of general circulation, and must be included in customers' water bills.

If you believe adequate measures are not being taken to correct problems in your drinking water supply system, you have the right under the law to petition EPA to hold hearings aimed at bringing the utility into compliance. You also have the right to bring suit against anyone you believe is violating the Act.

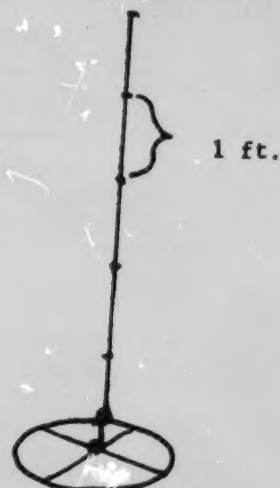
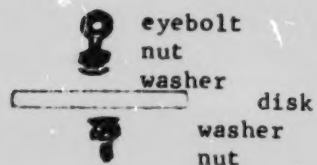
It is therefore important for you to know your local water supplier, understand the law, and keep aware of notices in your water bills and local newspapers by your water utility.

An informed citizenry, willing to exert a full measure of power, can demand and get safe water supplies. A willingness to pay the associated costs also is important. The widespread menace of typhoid and cholera was virtually wiped out earlier in this century because the public was ready and willing to shoulder the costs of proper water systems. That same attitude is even more important today in light of the discoveries scientists have made about the need for up-to-date measures to protect our drinking water.

SECCHI DISK

Materials: metal disk
eyebolt, nuts, washers
heavy cord, marked at 1 ft. intervals
black and white paint

top view

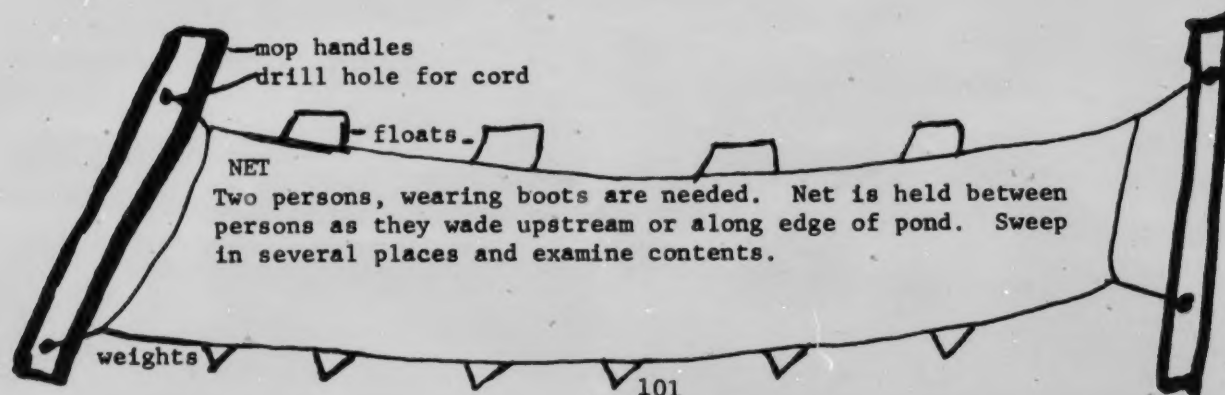


Procedure: Lower disk until it disappears and take first reading. Lower a few feet more and then raise disk until visible. Take second reading. Average reading 1 and 2 to obtain the limit of visibility.

SEINE NET

Materials: Mop or broom handles
Small mesh net
Weights (heavy washers or fishing weights)
Floats (cork or wood)
Heavy cord

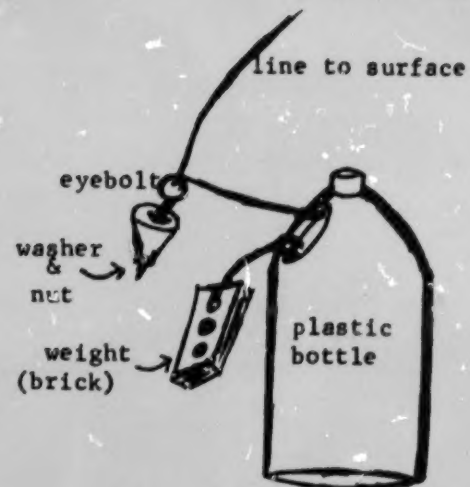
TOP



WATER SAMPLER

Materials: plastic bottle ($\frac{1}{2}$ or 1 gallon)
stopper (rubber or cork)
eye bolt, washer, nut, weight, and rope (or twine)

Procedure: Place stopper in bottle. Lower to desired depth. Jerk line to remove stopper and allow water to enter jug. Be sure that a string connects stopper to jug.



PLANKTON NET

Materials: nylon stocking
wire coat hanger
plastic vial
small fishing weight
light weight wire
rope or twine



Pull through water. Remove vial and examine contents.

TURBIDITY INDICATOR

Color of Particles Removed	Turbidity of Filtrate	Particle Size	Substance Removed (ex., clay)

TURBIDITY INDICATOR

Appendix ____ .5

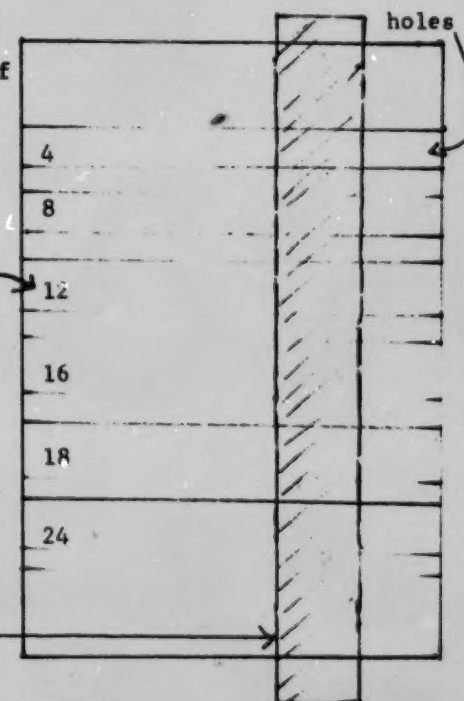
Materials: cardboard, plastic strips, clear tape

5 x 15 inch cardboard

Procedure: Cut out 6 1 x 2 inch holes. Layer plastic over holes increasing the number as indicator completed. Label according to number of plastic layers. Hold indicator next to each sample. Determine best match of color.

number indicator the number of plastic strips over hole

plastic strips taped in place



FOOD AND FIBER

FOOD

The cultivation of plants is believed to have begun about 6,000 B.C. This permitted a higher population density on the land, enabled people to provide in advance for food, and allowed a division of labor.

One of the most pressing problems in today's world is providing food for the multiplying millions of people and animals. Complicating this problem are the limited energy sources and other resources necessary for production and the environmental consequences of present agricultural practices and distribution.

Agriculture is the number one industry in the United States and in South Carolina. Seventy percent of South Carolina's land is farm and forest. However, much prime farm land is constantly being lost to highways or development. Food and fiber are essentials for life. The resource base that provides them must be maintained.

I was hungry and you circled the moon.
I was hungry and you told me to wait.
I was hungry and you set up a commission.
I was hungry and you talked about bootstraps.
I was hungry and you told me I shouldn't be.
I was hungry and you had napalm bills to pay.
I was hungry and you said, "Machines do that kind of work now."
I was hungry and you said, "The poor are always with us."
I was hungry and you said, "Law and order come first."
I was hungry and you blamed it on the Communists.
I was hungry and you said, "So were my ancestors."
I was hungry and you said, "We don't hire over 35."
I was hungry and you said, "God helps those . . ."
I was hungry and you said, "Sorry, try again tomorrow."

(Anonymous)

CONTENT

Population growth affects food supply.

A rapidly growing population can not continue to make demands on our renewable resources.

One severe drought occurring in the U.S. and in India the same year will result in 100 million people starving.

Our resources can be better utilized by people.

The average person in one of the world's poor countries consumes less than 400 lbs. of grain per year; a European about 1,000 lbs.; an American nearly 2,000 lbs. Americans consume much of their grains through meat and poultry.

STUDENT OBJECTIVES

The student will be able to:

Explain how exponential growth of the world's population will effect the individual here in S.C.

Describe the urgency of feeding 8 billion people by 2010.

Explain how our diet may effect the diet of a third or fourth world family and contrast diets.

STUDENT ACTIVITIES

Graph the world's population growth from 0 AD-2041 AD. Graph growth in S.C. Compare and discuss.

Class discussion: What are the effects of over-population? How does over-population effect land availability for agriculture? What alternatives do we have? Can we go back to the "good old days"?

Contrast your family's diet to that of a "third world" family diet.

Keep a record of the amount of food your family eats in a week. Divide into beef, pork, poultry, dairy products, and breads. Compute for a year. Convert the above meat consumption into grain equivalents. How long would your diet support one person in the "third world"?

RESOURCES

See attached chart, p. 117.

Cassette tape--very dramatic. To be used after discussion. "Fives Walk on Thursday." Charts 2 and 3, p. 118, 119.

Charts of third world included on p. 120-121.

Encyclopedia or school librarian.

Dupont Poster, 2x
Tons of Food, Free from Dupont Chemical Co. Corp., Wilmington, Delaware.

Conversion Chart:

1 lb. dairy products
= 3 lbs. grain
1 lb. poultry = 3 lbs.
grain
1 lb. pork = 5 lbs. grain
1 lb. beef = 10 lbs.
grain

CONTENT

Interesting Facts and Statistics

There is a chronic food shortage for over half the world's population.

Between 10-20 million people (mostly children) die per year as a result of malnutrition.

In 1970, 51% of man's energy came from grains.

Each farmer feeds himself and 48 other Americans (1976).

We spend about 17% of our take-home pay on food the smallest amount of any country.

American farms supply half of all the world's grain.

There are 10% more Americans now than in 1966, fed by 22% fewer farmers.

STUDENT OBJECTIVES

The student will be able to:

Show awareness of the following:

In 1976, American farms supplied half the world's grain. Each farmer feeds himself and 48 others. It is the export of American grain that keeps our nation's balance of trade in the black offsetting the deficit due to imported oil.

STUDENT ACTIVITIES

Why do you eat/not eat meat?
Would you be willing to make some changes in your diet?
Are there any necessary nutrients missing from grain diets alone?

Plan menus for your home, using Diets for A small Planet.

Debate: "The pros and cons of American grain sales to the Soviet Union."

RESOURCES

Scientific American,
September 1976.

Film: S.C. Agriculture On The Move, 28 min.,
Color. No charge.
S.C. Department of
Agriculture.

CONTENT

Distribution and use of non-renewable resources allocation of the world's limited resources. The U.S. has 6% of the world's population and consumes between 30% and 40% of its non-renewable resources, many of which are foods.

Interdependence of Energy and the U.S. Food System

Economic growth and technical advances have resulted in increased dependence on limited energy sources.

Energy consumption in food production from farm to table. (About 1¢ of the cost of a head of lettuce goes for farm labor.) Only 2-3% of total energy used in U.S. is used to produce food on the farm.

Mechanized agricultural production depends on a limited source of energy, oil and gas.

STUDENT OBJECTIVES

The student will be able to:

Name the countries which produce some basic food resources which we import. Name the countries to which we export.

Show how countries of the world are interdependent.

Show how the U.S. food and energy situations are related.

Describe the many varied uses of energy in agriculture.

Discuss the long-term relationship of modern agriculture and the decreasing supply of gas and oil.

STUDENT ACTIVITIES

Identify each country and the resource it produces.

Draw arrows from importing country to producing country. Discuss the many interdependencies.

Respond to Agricultural Inventory, pp. 125-126.

Discuss each statement and tabulate the results of the inventory.

Record the types of energy use in each step involved in food production.

Trace back the energy costs of a glass of milk from farm to table. Include transportation.

Read Gordon Berg's article "How Long will the Miracle Last?" Explain to the class.

RESOURCES

Charts 4 and 5 included, p. 120-121 and 122.

National Science Teachers Association. Interdisciplinary Student/Teacher Materials on Energy, the Environment and Economy, 1976. Chart 5, p. 122.

See chart 6, p. 123.

U.S.D.A. From the Earth to Your Table, free, Office of Communication, U.S.D.A., Washington, DC 20250.

See p. 138.

CONTENT

Modern agriculture can be a disruptive factor in an ecosystem.

Monoculture removes key nutrients from the soil.

Failure to allow dead plant tissue to return to the soil limits soil, air, water and micro-organisms.

STUDENT OBJECTIVES

The student will be able to:

List ways agriculture alters the ecosystem.

Describe effects of soil deficiencies in nitrogen, phosphate and potassium on plants.

STUDENT ACTIVITIES

Discuss the article keeping these items in mind:

Only 2-3% of the total energy used in U.S. is used to produce food on the farm.

What do you do when the fossil fuels run out?

Should farm production be given all the gas and oil it wants - with all else left to do what it can?

What about the rest of the world depending on U.S. for an important portion of their food?

Find out from your county agent the percentage of land lost to agriculture in your county and state due to harmful agricultural practices. What specific helpful practices would be applicable to a flower garden or home vegetable plot?

Plant seedlings of wheat or corn in containers of soil, each of which is lacking in one of the different essential ingredients. Suggestions: nitrogen, phosphorus and potassium.

RESOURCES

County agent. What's Ecology? McComb and Rosa, Addison-Wesley Publishing Co., Reading, Massachusetts 01867.

CONTENT

Removal of hedge row to provide more extensive use of land for agriculture destroys wildlife habitat.

Interruption of nitrogen cycle. Nitrates necessary for plants are depleted by repeated plantings of grain crops.

Pesticide Use

Different cultures use different agricultural practices. Agriculture in the U.S. has changed drastically since colonial days. (ex. from many small farms using animal and human energy to huge farms completely mechanized)

STUDENT OBJECTIVES

The student will be able to:

Explain how wall-to-wall agriculture destroys natural habitats for wildlife.

Explain the importance of nitrogen in the soil.

List the pros and cons of pesticide use and safety measures necessary.

Describe different types of agriculture practiced today and 200 years ago.

STUDENT ACTIVITIES

Label each as to kind of seedling, type of soil, and date.

Collect data on appearance, color, length of shoots, number of leaves, etc.

Prepare graphs and discuss results at the end of test period.

May also experiment with different proportions of some nutrient.

Using legumes or pictures show how presence or absence of nitrogen effects plants.

Discuss alternatives to pesticides.

Identify commonly used pesticides and the pros and cons for use of each.

Refer to history books, interview old and young farmers, and find out how agriculture has changed over the past 200 years.

Show film, The New Life, and discuss.

RESOURCES

The New Life, U.S. Soil Conservation Service, Graystone West, Columbia.

CONTENT

Cost vs. Nutrition

The Food Dollar may represent the energy investment but not nutritional value.

Agricultural lands are being used for urban development. Why not? When agricultural lands at \$400 per acre can be sold for \$2,000 an acre for development, more than three million acres of our best farm land is going to urban developing each year.

STUDENT OBJECTIVES

The student will be able to:

Show how each system varies in the input of fuel required to produce a calorie of food energy.

List differences between agriculture in the U.S. and that of other countries.

Examine the relationship between processing, price, and nutrition.

Identify local agricultural land that has been used for urban development.

STUDENT ACTIVITIES

Determine and compare energy use of different kinds of agriculture.

Simulation Game: A Global Agricultural Conference (p. 137).

Set up a chart as follows:

Item (ex.)	Pkg. Size	Price	
		Price	Per lb.
Fresh potato	20 lb.	1.99	.10
Frozen potato	10 oz.	.35	.56
Instant potato	1 lb.	.71	.71
Chip potato	10 oz.	.59	1.26

Calculate the cost of highly processed foods.

Compare the nutritional value of each.

Obtain a soil map of your county and determine which soils provide for good agriculture.

On a map shade the areas converted from farm to urban or suburban in the past 30 years.

RESOURCES

Grocery store.
Jacobsen and Wilson,
Food Scoreboard,
Center for Science
in the Public Interest,
Washington, DC, 1974.

Local Soil Conservation
Office

CONTENT

In 1930, S.C. had 165,000 farms and over 17 million acres under cultivation. Today, we have less than 55,000 on less than 16 million acres.

Nutritional values decline during storage. Of the total amount of food produced in the world, 20-50 percent is lost through spoilage.

Leftovers, soft foods, and spoiled foods can be recycled-preparing special dishes with leftovers, using soft fruits and vegetables in jams and jellies, or soups and stews.

STUDENT OBJECTIVES

The student will be able to:

Describe ways to reduce food waste.

List ways to prevent loss of food by spoilage.

STUDENT ACTIVITIES

Determine how many acres of agricultural land or farms are in use in your county today as compared to 15 years ago. Explain trends to your class and describe their impact in your life.

Discuss the reasons for loss of land to development before inviting the county agent to discuss loss of prime farm land.

Interview two local supermarket owners to determine the economic loss due to spoilage annually and their estimate of the effect on consumer prices.

Find out from the county Home Economist or school Home Economist ways to reduce food spoilage. Report to class.

Calculate the amount of spoilage and its cost in your home at the end of a week's time.

Discuss ways food could be recycled.

Prepare a special recipe with leftovers. Share the recipe with classmates.

RESOURCES

Local county agent

Dickey and Speight
"Going Home," S. C. Wildlife Magazine, March-April 1977.

U.S. News and World Report,
May 31, 1976.

CONTENT

Grain exports in 1976 kept our balance of trade from being in the red--offsetting the imported oil.

The American farmer now produces food to supply not only the needs of this country, but also a surplus for export, due to modern research, mechanization, better chemical aids, advances in soil and water conservation, and better marketing practices.

A major problem exists due to the fact that the American farmer's costs now have reduced his profit drastically.

226

STUDENT OBJECTIVES

The student will be able to:

Describe GNP as affected by U.S. agriculture.

List reasons for a surplus of food.

Identify cost-profit relationship.

113

STUDENT ACTIVITIES

Prepare a special dish with old softened fruit or vegetables. Share.

Start a compost pile with spoiled food.

Look up "GNP" and define it.

Compare farm output per acre of a particular crop (e.g., corn) in the U.S. to that of other countries.

Talk to local farmer about the basic changes that have occurred in farming in the last 20 years.

Talk to local farmers involved in a farm strike. Discuss their problems. Develop possible solutions.

Interview a local farmer. Find out costs of equipment, chemical aids, etc. How do these investments affect the cost-profit relationship?

RESOURCES

See county agent for instructions for compost pile.

U.S. News and World Report, The Nation's Greatest Success Story, May 31, 1976. Also chart 7.

U.S. Department of Agriculture, or National Geographic, The Revolution in American Agriculture, February 1970.

Local farm leaders

227

CONTENT

Agriculture is S.C.'s largest industry, bringing in \$4.9 billion currently up from \$2.2 billion in 1967. Soybeans are now our top cash value crop; tobacco is second. Other important crops are cotton, corn, wheat, oats, barley, hay, fruit, and vegetables.

Oil Crisis

Climatic Changes

Poverty Programs

STUDENT OBJECTIVES

The student will be able to:

Involve himself in political processes to help bring about changes.

Determine effect of oil shortage on agriculture.

Tell how climate affects food production.

Gain knowledge of present programs.

STUDENT ACTIVITIES

Look up use of oil in the production of food.

Class discussion on national food-energy issue.

Research problem and show relationships between climate and food such as:

Drought in Sahael

Drought in Midwest

Monsoon failures in India

Poor rice crops in Asia

Survey of feeling about poverty programs:

Research food stamp information

Research lunch room programs

Research WICH Program

Research AID Program

RESOURCES

Encyclopedia
Oxford Atlas of the World

Magazines, newspapers,
social studies books such
as World Geography Today.

CONTENT

Use of Pesticides

Monoculture

Farm Subsidation

Hunger

230

STUDENT OBJECTIVES

The student will be able to:

Identify results of pesticides on living matter.

Show the results of one crop economy on the nation.

Describe the effects of a monoculture on soil productivity.

Define farm subsidation.

Become sensitized to the needs of people who are starving.

115

STUDENT ACTIVITIES

Determine necessity of use of specific pesticides, possible changes needed, and additions.

Debate: Pesticides--to use or not to use.

Compare the attempts to set up a Common Market in Central America with those of West Europe.

Discuss with the county agent the results of one crop usage alone.

Research farm subsidation and report on its importance to agriculture.

Third world simulation game.
View film Bread for the World.
Read Bread for the World.
Debate: Can the U.S. continue to waste food while people starve? Develop a list of changes in life style that would reduce food waste and which you would be willing to implement now. Read bills before Congress, vote, write representatives.

RESOURCES

Check with local extension office for latest information on pesticides and use of natural deterrents.

See chart p. 124.

231

CONTENT

Pet Population

Pets consume a great deal of nutritional food which could otherwise help feed hungry people of the world.

STUDENT OBJECTIVES

The student will be able to:

Discuss control of dog and cat population and channel resulting savings into programs to feed hungry people of the world.

STUDENT ACTIVITIES

Inventorying waste: Instruct students to collect labels from various cat and dog foods and calculate the amount of protein in each can. Form teams to survey the neighborhood and find out how many pet cats or dogs there are. Calculate the amount of protein used to feed those animals (based upon an approximate, per animal, daily intake).

It has been suggested that there are 40 million cats in the U.S. If each cat eats 100g of fish per day, how much protein is consumed in this way? How many persons could be fed on that amount of protein?

RESOURCES

Energy, Food, and You,
an interdisciplinary curriculum
guide for secondary schools,
Washington, State Office of
Public Instruction.

Chart 1

Year	Est. World Population	Population Increase	Doubling Time	Add at End of This Interval	Add Students to Area	Total # in Circle
						1 (start)
0	250 mill.					
1650	500 mill.	250 mill.	1650 yr.	155 sec.	1	2
1850	1 bill.	500 mill.	200 yr.	20 sec.	2	4
1930	2 bill.	1 bill.	80 yr.	8 sec.	4	8
1976	4 bill.	2 bill.	46 yr.	4.6 sec.	8	16
2011	8 bill.?	4 bill.	35 yr.	3.5 sec.	16	32
2041	16 bill.?	8 bill.	30 yr.	3.0 sec.	32	64

Chart 2

WORLD'S RESERVES OF FERTILIZERS

Resource	Phosphorus		Nitrogen Produced		Potash	
Country or Region and World's %	Morocco	41%	Europe	35.0%	Canada	42%
	U.S.	23%	U.S.	22.0%	U.S.S.R.	26%
	U.S.S.R.	7%	U.S.S.R.	17.6%	E. Germany	13%
	Australia	2%	China	6.6%	W. Germany	13%
	Sp. Sahara	2%	Japan	5.3%	Jordan, Isr.	3%
	China	2%	Other	13.5%	U.S.	1%
	Other Afr.	8%			Other	2%
	Other	15%				
	TOTAL:	100%	TOTAL:	100.0%	TOTAL:	100%

WORLD'S CONSUMERS OF FERTILIZERS

Phosphorus		Nitrogen		Potash	
U.S.	19.0%	U.S.	21.0%	U.S.	22.0%
U.S.S.R.	11.0%	U.S.S.R.	16.0%	U.S.S.R.	17.0%
France	9.0%	China	10.0%	France	8.7%
China	6.0%	India	4.6%	Poland	6.7%
Australia	5.0%	France	4.6%	W. Germany	5.3%
W. Germany	3.7%	W. Germany	2.8%	Other	40.3%
Poland	3.4%	Poland	2.5%		
Other	42.9%	Other	39.5%		
TOTAL:	100.0%	TOTAL:	100.0%	TOTAL:	100.0%

Chart 3

Oil Reserves and Wheat Exported
(% of World's Total)

Oil Reserves 1972		Wheat Exported 1963	
Middle East	67.0%	U.S.	39%
China, U.S.S.R.	9.6%	Canada	25%
N. America	8.5%	Australia	12%
Africa	5.8%	Argentina	8%
S. America	4.6%	France	7%
Other	5.0%	U.S.S.R.	5%
		Other	4%
TOTAL:	100.0%	TOTAL:	100%

Energy Consumed and Wheat Imported
(% of World's Total)

Energy Consumed		Wheat Imported 1965	
N. America	35.0%	U.S.S.R.	12%
China, U.S.S.R.	22.0%	India	11%
Europe	19.5%	China	11%
Asia	8.0%	U.K.	9%
S. America	3.8%	Japan	7%
Africa	2.0%	Brazil	5%
M. East	1.0%	Other	45%
Other	8.7%		
TOTAL:	100.0%	TOTAL:	100%

(Charts 2 and 3: Figures taken from Man's Domain and Oxford Economic Atlas of the World.)

<u>TYPICAL AREAS</u>	<u>DOMINANT ANIMALS</u>	<u>OWNERSHIP PATTERN</u>	<u>SETTLEMENT TYPE</u>	<u>ECONOMIC STAGE</u>	<u>POPULATION DENSITY</u>
Amazon Basin New Guinea	Dog	Nuclear family; clan	Temporary scattered huts	Subsistence in a nonmarket economy	2-3 per square mile
No. Burma, Thailand, African high- lands, Latin America	Dog, pig, Chicken, goat	Tribal usufruct (often matri- archal), village communal	Loosely nucleated village	Barter; proto- feudal	15-20 per square mile
Indian Peninsula (mountains), Native American	Oxen, cattle, horse, sheep	Extended family; communal, with occasional periodic re- distribution	Tightly nucleated village	Early feudalism	50-100 per square mile
North Europe (Middle Ages) Laxton	Oxen, cattle, horse	Serfdom	Manorial cluster	Late feudalism	100-150 per square mile
Traditional China; Heian Japan	Bullock, horse water buffalo	Communal with periodic redis- tribution	Nucleated villages along break- of-slope	"Centralized" (hydraulic) feudalism	200-600 per square mile
North Europe (modern)	Dairy cattle, horse, oxen, pig	Individual freehold; tenant-at-will	Individually dispersed or nucleated	Small-scale capitalism (emphasis on individual effort)	150-300 per square mile
Italy, Greece, So. Spain	Oxen, donkey	Extended patriarchal family	Nucleated hillside villages	Semi- subsistence	400-600 per square mile
Guatemala, Malaysia	None	Corporate, latifundia	Workers' permanent dormitories	Corporate capitalism	50-100 per square mile
United States, Argentina, U.S.S.R.	None	Large Private operation under capitalist govern- ment subsidy; state farms in socialist areas	Shelters for mi- gratory workers & crop process- ing & storage sheds; agrovilles in socialist areas	Private large-scale capitalism, socialism	Serves urban population exclusively

A TYPOLOGY OF MAIN AGRICULTURAL TYPES, WITH SOME RELATIONS TO LIFE AND ECONOMY

AGRICULTURAL TYPES	COMMON TOOLS	CROP EMPHASIS	TYPICAL CROPS	LAND PATTERN	HYDRAULIC PATTERN
Migratory shifting cultivation	Digging stick	Individual plants of few varieties; leisurely experi- mentation with "camp-follower" plants & indivi- dual "found" trees	Taro, yams, upland rice, breadfruit, other tubers	Amorphous	Rainfall
Bush swidden shifting agri- culture with a definite base)	Primitive hoe	Individual plants of more varieties; mixed planting; individual planted trees	Upland rice, taro, yams bananas, tree fruits, maize, beans	Garden	Rainfall
Primitive fallow	Developed hoe & mattocks; rudimentary wooden plow	Field crops, clear-planted with no inner-row cropping	Maize, beans, millets, sor- ghums, squash, buckwheat	Scattered field	Rainfall irrigation
European manorial system	Iron-tipped wooden plow	Three-field system; rotation of grain crops, pasture & fallow	Wheat, rye, barley, oats	Fields large but fragmented into small parcels. Ani- mals grassed on the fallow	Rainfall
Oriental rice farming with dry winter grains	Wooden harrow; iron-tipped wooden plow	Intensification of plant yields; win- ter grains inter- cropped with vegetables	Irrigated rice; barley, wheat	Many scattered fields; frag- mentation	Irrigation
Mixed farming	Iron plow with share	Heavy manuring, intensive tillage, dairy animals	Potatoes & other root crops, maize, wheat, clover, alfalfa, brassica	Compact farm unit; distinct fenced fields	Rainfall
Mediterranean agriculture	Hoe, iron plow, harrow	Three-story horticulture	Olives, grapes, wheat, figs	Fragmented plots, terraces	Irrigation
Tropical planta- tion	Steel plow; few other tools	High-yielding perennial plant types	Sugar cane, rubber, coffee bananas	Large blocks, surrounded by selva	Rainfall, some irrigation
Mid-latitude monoculture (capitalist & socialist variants)	Steel plow, mechanical harvester, combine, disc	Hybridization, emphasis on annuals; scien- tific experiment- ation	Wheat, maize, sorghums, rice, soybeans, field vegetables	Large blocks joining each other not visually	Rainfall, pump irrigation

Chart 5

Country	Area in KM	% of land in agri- culture	% of land in cities/ waste lands	% of people in agricul- ture and forestry	% of people in manufac- turing	Energy* per Capita	GNP per Capita in US \$	Number of Tractors 1972
Brazil	8,511,965	3.5%	23.1%	51.6%	8.9%	435	750	175,500
Cuba (1946)	114,524	17.2%	22.7%	41.5%	16.6%	949		6,000
France (1964)	551,601	38.1%	15.8%	19.8%	26.9%	3314	4,851	1,400,000
Guatemala (1958)	108,889	13.5%	36.8%	64.7%	11.5%	196		3,400
India (1964)	3,268,081	49.6%	29.0%	72.9%	9.5%	157	117	67,000
Japan (1960)	369,662	16.2%	12.5%	26.9%	23.6%	2755	3,812	280,000
Kenya (1961)	582,600	2.9%	87.5%	35.3%	12.0%	145		6,650
U. A. R. (1965) (Saudi Arabia)	1,000,000	2.7%	97.3%	56.7%	9.1%	813	1,620	800
U.S.S.R. (1964)	22,400,000	10.3%	32.5%	35.2%	33.6%	3825		2,111,900
U. S. (1959)	9,191,802	19.8%	20.6%	6.2%	25.6%	9500	6,155	4,387,000
U. Kingdom (1965)	229,827	30.7%	12.2%	3.1%	34.8%	4650		459,870

AGRICULTURE, ENERGY CONSUMPTION, AND GNP

*Each EU is equivalent to one ten thousandth of the energy expended by the average American in 1972. To be more specific, one EU is 34,300 British thermal units or around 10 kilowatt hours.

Sources: Energy Per Capita--Fritsch, et al., Lifestyle Index, Center for Science in the Public Interest, 1974. (Write for the updated version of this very useful guide.)
All other figures--U.N. Statistical Yearbook, 1976.

Chart 6

Examples of the Flow of Energy in Food Production

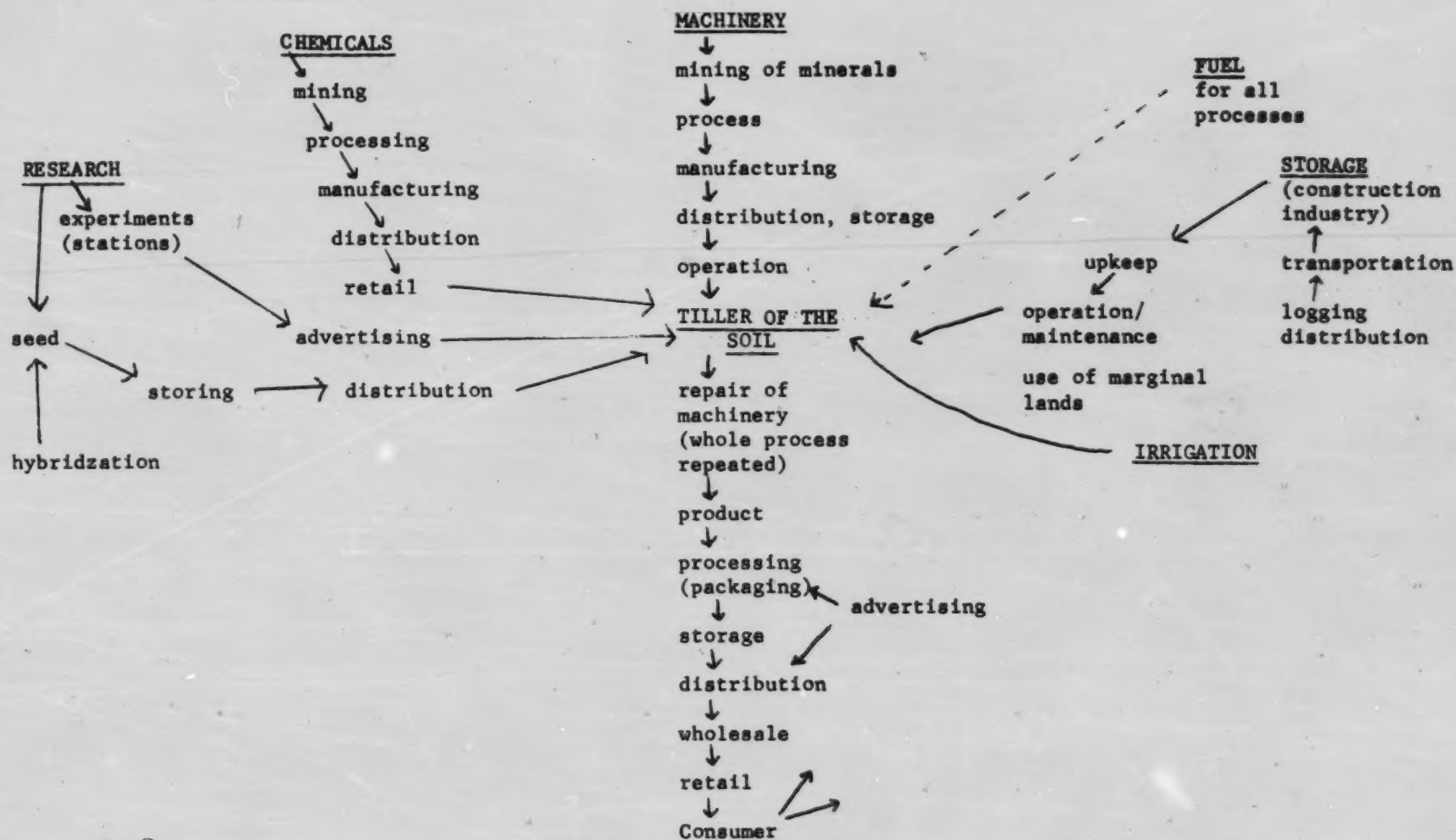


Chart 7

Changes in Agriculture in the U.S.

<u>1947</u>		<u>1970</u>
34	Corn Yields Bushels/Acre	81
23	Work Hours Labor/Acre of Crop	9
0	Pounds of Insecticides/Acre	1
7	Pounds of Nitrogen/Acre	112
Total energy input in kilo-		
calories used in corn production		
925,500		8,164,800
Total energy yield of corn		
in kilocalorie		
3,427,200		8,164,800

245

INVENTORY

Directions: Read carefully each statement. For each statement place a check (✓) in the column which most nearly indicates your opinion. The symbols represent the degree of your opinion.

SA = Strongly Agree
D = Disagree

A = Agree
SD = Strongly Disagree

N = Neutral or Don't Know

1. To help conserve fossil fuels, Americans should eat less meat.
2. It is possible to reduce the rate of energy used and still provide every American with an adequate diet.
3. Rising food prices in the past five years have been mostly due to higher oil prices.
4. The United States should encourage people in developing nations to use our farming and food processing methods.
5. The amount of petroleum used on American farms is greater than that used in private automobiles.
6. We get energy from food we eat; however, today, we use more energy in growing and preparing food than we get in energy out of it.
7. A farmer's expenses can affect my life.
8. Processing food uses more energy than growing food.
9. Each acre of crop land becomes more productive as more fertilizer is applied.
10. Farm workers and farm animals are more energy-efficient than tractors and other machinery.

SA	A	N	D	SD

Inventory Con't.

11. The energy a farmer uses is comparatively cheap when you consider what he produces with it.
12. Our farmers rely on domestic supplies of oil and natural gas to run their farms.
13. When we eat food, we're eating up our oil supplies for the future.
14. The fact that we all have household helpers like electric appliances has less to do with the rate of energy use than the fact that we simply have more people.
15. Sometimes less can be more. We have fewer farms today, but each farmer produces more. This situation can go on forever.

SA	A	N	D	SD

FIBER

The present forest acreage in the United States is 761 million acres--510 million of which are capable of producing commercial timber. Of these acres, 198 million are in the South and 12.4 million in South Carolina. There are more than 1000 kinds of trees in the United States but only about 100 have commercial value.

Forestry has always played an important role in South Carolina history. Colonists stripped forests for settlement, causing erosion and siltation. This silt in coastal river bottoms contributed to the decline of the rice industry. More recent disturbances have resulted from large-scale water control structures, power plants, and reservoirs.

Sixty-four percent of the total land in South Carolina is woodlands. At present, the forest growth is exceeding timber cut. Forestry planting peaked in the 50's due to special federal incentives. As many as 140 million seedlings were planted annually. Five million acres are presently not in production. One million acres have recently been abandoned for agricultural purposes and are not productive.

In 1977, forestry was South Carolina's third largest industry, providing directly 30,000 jobs with a payroll of \$230,000,000 and generating a total of almost 1½ billion to our state's economy. There are over 500 forest-related industries in South Carolina. Three-fourths of South Carolina's forests are privately owned, 16 percent are owned by industry, and 9 percent by the state. A major problem is mismanagement or lack of management on privately owned forestlands.

CONTENT

Plant Interaction and Change

Succession is the gradual replacing of one community of plants and animals with another until the climax stage is reached.

In the Piedmont area of South Carolina and the Southeast United States, the succession from field to climax forest takes about 150 years or more.

STUDENT OBJECTIVES

The student will be able to:

Define succession.

Describe the steps in the succession of plant community from bare field to climax forest.

Define "pioneer plants" and describe their special adaptations.

STUDENT ACTIVITIES

Trace the history of plant succession in your neighborhood.

Observe and record changes in plant communities in a vacant lot near school over a period of several months.

Visit the site of a forest fire and observe and record the difference in plant growth with that of a non-burned forest.

Find an unused corner of the school ground and record your observations of changes that occur there.

Find out what the typical climax forest consists of in your area. Explain succession in your part of the state.

Identify value and adaptations of pioneer plants.

Visit the exhibit at Charlestown Landing.

View a film on succession.

RESOURCES

Hopkins, Sally. Concepts in Environmental Education.

S.C. Wildlife and Marine Resources Department.

Hopkins, Sally. "From Field to Forest." S.C. Wildlife, Vol. 22, no. 3, May-June 1975.

McCombs, Lawrence and Nicholas Rosa. What's Ecology? Addison Wesley, 1973.

BSCS. Environmental Biology. W. B. Sanders, 1976.

"We Can Have Wilderness Wherever We Choose." National Wildlife, August-September 1973.

Succession, From Sand Dune to Forest, USC.

Plant and Animal Communities - Ecological Succession. S.C. State Forestry Commission.

CONTENT

Multiple Uses of a Renewable Resource

Commercial: There are over 5,000 commercial products made from wood. Wood cellulose plastic claims 25,000 uses. About 36 billion board feet of lumber are used in the U.S. each year. About 2/3 of that goes into construction. Annual per person use of paper and paper board products is 572 lbs.

Aesthetic and Recreational: Because of the increase in population and economic status, more lands are needed for recreational purposes. S.C. presently has 30 state parks comprising 50,000 acres. Projected need by 1984 is 128,000 acres.

STUDENT OBJECTIVES

The student will be able to:

Identify types of trees in S.C.

List some of the many uses of wood and wood products. (ex., wood derivatives, tanning, fats, resins, gums, pigments, oils, drugs, beverages, etc.)

Describe our state park system and its values to the citizens.

Describe the value of trees and woodlands as they have influenced art and music.

STUDENT ACTIVITIES

Make a collection of tree leaves. Press and note where the tree was growing, when leaves were gathered, and several uses for each.

Name the 10 most commercially valuable trees in the U.S. and in S.C.

Look around your home and make a list of all the wood products that you use.

Read and report to class - "Trees Life's Greatest Ally," John Culler, S.C. Wildlife, Winter 1971.

Visit a state park near you and report on its aesthetic and recreational value to a family.

Listen to music of the forest.

Identify trees in the school ground and along the street, noting reasons for their special attractiveness.

RESOURCES

From S.C. Forestry Commission: Important Trees of Eastern Forests, Familiar Trees of South Carolina. Film: Extra Forest Dollars, 10 Lessons in Forestry.

A Practical Guide for Environmental Activities. Penny Cowan, S.C. PRT.

From American Forestry Institute: charts--Products of the Tree Farm, Forests of the U.S.

Records: Forest Murmurs from Siegfried, Tales from the Vienna Woods by Strauss, Forest Music by Handel, Pastoral Symphony by Beethoven.

CONTENT

Medicinal: The U.S. Forestry Service reports 126 marketable species of medicinal plants growing in Appalachia (ex., sycamore bark boiled in water for poison ivy). Nearly 50% of prescription ingredients come from plants.

256

STUDENT OBJECTIVES

The student will be able to:

Describe some old native remedies using plants.

130

STUDENT ACTIVITIES

Ask your grandparents or some older local residents if they know of any old health remedies using trees or their parts.

Interview your local pharmacist or write to the pharmacy department of the State Medical University for information concerning use of plant parts for medicine.

Research the topic in the library and write a report.

RESOURCES

Leaf from S.C. Forestry Commission.
Time Lapse Studies of Growing Trees. S.C. Forestry Commission.
Film: Carolina Heritage. S.C. Wildlife Department.

S.C. highway map.
S.C. Vacationland from the Mountains to the Sea, from Land Resources Department.
"Appalachian Trail in Need of Protection." Conservation News. National Wildlife Federation.

"Francis Marion's Forest" S.C. Wildlife.
November-December 1976.
Aikmon, Lonnella. "Nature's Gift to Medicine." National Geographic, September 1974.

Morton, Julia. Folk Remedies of the Lowcountry E.A. Seemann Pub. Co., Miami, Florida, 1974.

Forest and the Natural Water Cycle from the S.C. Land Resources Department.

257

CONTENT

Role of Trees in the Ecosystem

Reduce Air Pollution: By filtering particulate matter and "fixing" carbon (removing carbon from the air) age of tree $\times$ 4 = lbs. of carbon dioxide absorbed per year.

Control Soil Erosion: Tree roots and leaf litter help prevent erosion and reduce sedimentation. They protect valuable watersheds.

Give Off Oxygen: Age of the tree $\times$ 3 = lbs. of oxygen given off by a tree per year.

Modify Climate: Temperature--daily evaporation from one tree reduces temperature about 8° F and up to 12° on a hot day. Wind reduction. Add moisture to the air--one large elm tree, temperature 80° F can release 150 gallons of water.

STUDENT OBJECTIVES

The student will be able to:

Describe the roles trees play in the environment

STUDENT ACTIVITIES

Explain the role trees play in reducing air pollution.

Confer with local conservation district personnel about finding an area with erosion problems that could be restored by tree planting (ex., old mined area). Plan restoration of the area.

Interview friends or neighbors with similar homes and family size, shaded and unshaded. Determine the difference trees make in their air conditioning bill. (The larger the number interviewed, the more reliable the estimate.)

RESOURCES

The Role of Trees in Reducing Pollution, S.C. Land Resources.

Trees for Polluted Air, S.C. Forestry Commission (no. 1230).

What's Ecology?

Controlling Erosion on Construction Sites, S.C. Land Resources Department.

Sediment, S.C. Land Resources Department.

CONTENT

Reduce Noise: Trees absorb rather than reflect sound. Each 100 ft. in depth of forest is believed to dissipate about 6-8 decibels of sound. S.C. Highway Department uses trees for noise control along highways.

Natural Enemies

Animals: Bears rip bark to get to sap, deer eat seedlings, porcupines eat inner bark, wild hogs root up seedlings, rabbits and rodents eat seed and seedlings, domestic cattle and sheep eat seedlings and bark of exposed roots of large trees.

Floods: Wash out roots and cause trees to fall.

STUDENT OBJECTIVES

The student will be able to:

Describe natural enemies of trees.
List ways that these enemies may be limited or controlled.

STUDENT ACTIVITIES

Using a decibel meter, check noise level on both sides of a tree barrier (ex., around a ball field, along a highway).



Take a field trip with a local forester to check a wooded area for evidence of tree damage by any of forests' natural enemies.

Find out how much damage is done annually to S.C. forest by natural causes and what is being done to protect them.

Check with Corps of Engineers and power companies for information on flood control.

RESOURCES

It's Tree Country,
American Forest Institute
or S.C. Forestry
Commission.

Forest Insects and
Diseases

CONTENT

Diseases and Insects: During an average year, forest insects and disease kill 7.3 billion board feet of timber trees.

Fire: The three main causes of fire are "men, women and children"; 99% are caused by human carelessness. In the U.S., 4.7 million acres burned in 1967. In S.C., 75,185 acres burned in 1975-76.

262

STUDENT OBJECTIVES

The student will be able to:

Describe the responsibility of individuals and government agencies in caring for and managing the forests.

133

STUDENT ACTIVITIES

Investigate the use in our state of remote aerial imagery to locate damage caused by disease or insects.

Determine how much your state and federal government spends on controlling insects and diseases yearly. Compare these amounts to the value of the forests protected.

Debate the issue - pesticide or pollution as it regards treatment of forests.

Collect pieces of wood showing typical insect and disease damage and explain how these diseases can be spotted and treated.

Find out what diseases are most common in local city trees and what the individual home owner can do to help protect and save his valuable trees.

Find out what has caused the major forest fires in S.C.

Obtain as much information as possible on "prescribed burning" and debate the value of this procedure as a deterrent to major forest fires.

RESOURCES

Environmental Quality,
Supt. of Documents,
U.S. Government Printing
Office, Washington,
DC 20402.

263

CONTENT

Weather: Snow and ice break limbs, and lightening kills, damages or starts fires. Long dry spells can also damage trees.

People: Litter and cause fires, but also manage and protect forest.

Economic Impact
Currently in S. C., forestry is our third largest industry, providing 130,000 jobs, having a payroll of \$230,000,000 and bringing over a billion dollars to our state's economy. There are between 500 and 1000 forest-related industries in S. C.

STUDENT OBJECTIVES

The student will be able to:

Describe the responsibility of individuals and government agencies in caring for and managing the forests.

Describe the economic importance of the forest industry to S.C. and to himself.

STUDENT ACTIVITIES

Check with Park's Service and/or tree surgeons to find out how they treat trees after ice storms.

List and then discuss some forest abuses in your neighborhood, county or state and actions that may be taken against them.

Interview the local forester and find out what management techniques are used in your area.

Choose an area to clean the litter and trash as an example for others.

Find out how many people in your county are dependent on forestry and forest-related industry for their income.

Obtain information concerning forest careers and report on job opportunities in this area.

Find out about the "Tree Farm" program in S.C. and how you can become involved.

RESOURCES

The Gifts, S.C.
Wildlife Department.

Film: Forest Murmurs,
S.C. Forestry Commission.

Report of the State
Commission of Forestry
for the Year 1975-1976.

CONTENT

Future

Timber is in reasonably good supply nationally. The future, though, is uncertain. Demand is expected to double by the year 2000 and debate on timber management practices has intensified (ex., rate of harvest and replacement of old growth stands.)

Issues

...Water pollution resulting from timber harvesting, road construction, and log decks.

...Clear-cutting--when an area is completely cleared of all merchantable trees.

...Short rotation.

...Monoculture--(in S. C., usually pine) only one tree species is grown.

STUDENT OBJECTIVES

The student will be able to:

Explain the problems of forest management for increasing population needs (ex., social and economic pressures for more and better housing).

List forestry practices that pollute water and the EPA regulations to prevent pollution.

List some pros and cons concerning clear-cutting and short rotation pine monoculture.

Explain some of the problems and risks associated with the "Green Revolution."

STUDENT ACTIVITIES

Make a report on plans and activities of foresters to prepare for the year 2020.

Interview a forester or forest industry about present management practices.

Class debate: Clear-cutting or short rotation pine monoculture.

Arrange for an interview with plant geneticists or seed salesmen or others in silvaculture.

RESOURCES

Film: The Eternal Forest, S.C. Forestry Commission.

Knight, Herbert. S.C.'s Timber Resources, S.C. Forestry Commission.

Environmental Quality

Clear-cutting, American Forest Institute.

"Stripping the Forest Bare, Why all the Furor," U.S. News and World Report, May 31, 1976.

"Green Revolution; Problems of Adapting a Western Technology," Science, Vol. 186, December 27, 1976.

CONTENT

- ...Management practices--such as use of chemical pesticides, prescribed burning, chemical control of underbrush.
- ...Beavers--increase in the beaver population has resulted in increased destruction of forests resulting in loss of timber, flooding, damage to agricultural land.
- ...Congaree, Russel Dam, etc.
- ...Pollution from paper companies.
- ...Management practices vs. wildlife (ex., Bachman's Warbler--an issue settled amicably between foresters and Wildlife Federation).
- ...Red-cockaded woodpecker--requires leaving stands of old trees.

268

STUDENT OBJECTIVES

The student will be able to:

- List some pros and cons of management practices that carry short- and long-term risks.
- Identify factual information from numerous sources and discuss the various forest-related issues.
- Determine effectiveness of pollution control efforts on the part of paper companies.
- Identify projects carried out to promote wildlife habitats.

STUDENT ACTIVITIES

- Game: Indian Valley Forest Management game. This is a simulation game involving all aspects of multiple use.
- Obtain as much information as possible and conduct a mock public hearing on any of the issues listed. Some may be "closer to home" than others (ex., Congaree as related to timber harvest and other uses).
- Arrange a visit from an expert to speak to class on their efforts and controls of pollution.
- Speaker: Forester to talk on multiple use and the management activities that they use to promote and improve wildlife habitats.

RESOURCES

Game from S.C. Forestry Commission, or American Forest Institute.
See p. 219.

Paper company representatives

269

SIMULATION GAME GLOBAL AGRICULTURAL CONFERENCE

1. Examine chart 5 (p.121-122) and discuss.
2. The class chooses one delegate from each of the different types of agricultural societies currently found in the world today. (Take one day for planning by students; they may wish to come dressed to play the part on the next day.) Other members of the class choose a delegate to work with and begin planning for the conference.
3. Each group chooses a symbol to represent their type of agricultural society. These symbols are placed on a large world map so that the distribution of each agricultural society may be clearly seen.
4. When the conference convenes, each delegate is seated behind the symbol representing his type of agriculture. Each delegate will address the group with the following materials (or pictures):
 - ... tools commonly used in his agricultural society
 - ... a container of typical products
 - ... pictures of animals associated with agriculture
 - ... pictures of the delegate's home and family
 - ... a diary of a typical farm day
 - ... a chart showing the energy input into the agricultural system compared with the energy provided by the food produced
 - ... an environmental impact statement describing the effect of the agricultural practices on the ecosystem

HOW LONG WILL THE "MIRACLE" LAST?

The energy crisis is teaching us many things. One of them is that there would be no "miracle" of U.S. farming without energy and mechanization that requires it in such abundance.

Michael J. Perelman, assistant professor at California State University at Chico, recently wrote in Conservation Foundation Newsletter: "If we should decide to measure efficiency in terms of the conservation of energy, then American agriculture comes out very poorly."

Quite a shock, isn't it?

Energy is something Americans have never had to worry about. We took it for granted--just as we always take our ability to produce food and fiber for granted.

Quenton M. West, administrator of USDA's Economic Research Service, says that "while we have about doubled our farm output in the last 30 years, we have more than quadrupled our fuel consumption so that farm output per gallon of fuel has declined by half." He said that fuel consumption by U.S. agriculture has increased to eight billion gallons a year.

"Counting the whole process of growing, processing, transporting, wholesaling, retailing, refrigerating and cooking, food probably accounts for 12 to 13% of the U.S. total energy requirement," he added.

But before you become too disillusioned, let's "hear it" from another expert.

"Although agriculture will be pressured to save energy, its needs are such a small part of the total energy budget that even a marked saving in agriculture will add little to the national pool," reports Frank G. Viets, Jr., chief soil scientist, Western Region, ARS, USDA.

"Agriculture in farm production uses less than 3% of the gasoline and diesel fuel, less than 3% of the electricity, and less than 3% of the natural gas for synthesis of nitrogen fertilizers."

"Any significant reduction in energy available for the direct production of agriculture products is a dangerous tampering with the food supply."

Sid Bierly, general manager of the California Fertilizer Institute, provides more food for thought on this crucial issue.

"It is interesting to note that while it requires about 23,000 cubic feet of gas for hydrogen feed-stock going into one ton of ammonia, plus about 11,000 cubic feet for fueling the ammonia plant, only 1.5% of total gas consumption goes into agricultural ammonia production. About 0.5% goes to other ammonia applications."

Agriculture's dependence on fossil fuels has brought the California Fertilizer Institute out fighting! We commend this organization for its far-sighted program to conserve fossil fuel energy!

The CFA is calling for a crash program of nuclear-fueled electric power generating plants across the country. The idea is to relieve the fertilizer industry.

Natural gas is tied very closely to that of crude oil, oil shale, and coal--and all fossil fuels. CFA feels that many consumers of natural gas as a fuel can and should convert to other fuels--thus freeing available gas for ammonia production and domestic uses.

Bierly tells us that atomic reactors for electric power generation will ultimately replace fossil fuels for electric energy generation.

"Collectively, we as an industry-representative association, in cooperation with agriculture and other interests, and each of us as individuals, can do much to bring this about," he urged, "by making our wishes known in no uncertain terms to the state and federal agencies which have jurisdiction."

CFA presented formal testimony to California's gas allocation authority, the Public Utilities Commission, last month in San Francisco and Los Angeles. CFA asked for a second priority on available gas to their ammonia industry, which now has a number six priority.

"Even that will have little meaning unless a reliable supply can be assured," Bierly said.

This is the kind of program we should all get behind and push with every ounce of energy! No one can explain the problem to the public better than the professionals in agriculture. The alternative is to allow agriculture to become weakened just as Malthus once again is "rearing his head."

The miracle of U.S. agriculture can and must continue!

Gordon Berg, Editor

Source: Agro-Fieldman Journal. Material was provided to visiting teachers by College of Agriculture, WSU.

REFERENCES

- Aikmon, Lonnella. "Natures Gift to Medicine." National Geographic. September 1974.
- American Forestry Institute: Products of the Tree Farm (chart)
It's Tree Country
Clear-cutting
- Borgstrom, George. World Food Problems. New York: Intext, 1973.
- Borlaug, Norman E. "The Green Revolution: For Bread and Peace," Science and Public Affairs. June 1971.
- Brown, Lester R. "Human Food Production as a Process in the Biosphere." Scientific American. 223:3, 1970.
- Brown, Lester R. "Population and Affluence: Growing Pressures on World Food Resources." Population Bulletin. 29:2, 1973.
- Brown, Lester R. The Politics and Responsibility of the North American Breadbasket. 1975, 43 pages.
- Brown, Lester R., and Gail W. Finsterbush. Man and His Environment: Food. New York: Harper & Row, 1972.
- BSCS. Environmental Biology. W. B. Sanders, 1976.
- Cowan, Penny. A Practical Guide for Environmental Activities. S.C., Parks Recreation and Tourism.
- Dickey and Speight. "Going Home." S.C. Wildlife. S.C. Wildlife Department, Columbia, SC, March-April 1977.
- Dupont Chemical Company, Wilmington, Delaware. Poster: "2½ Tons of Food." Free.
- Eckholm, Erik and Frank Record. The Two Faces of Malnutrition. 1976, 64 pages.
- Eckholm, Erik and Lester R. Brown. Spreading Deserts -- The Hand of Man. 1977, 44 pages.
- Environmental Quality. Supt. of Documents, U.S. Government Printing Office, Washington, DC 20402.

"Green Revolution; Problems of Adapting a Western Technology." Science. Volume 186, December 27, 1976.

Hitch, Charles J. Resources for an Uncertain Future. Baltimore, MD: The Johns Hopkins University Press, 1978.

Hopkins, Sally. Concepts in Environmental Education. S.C. Wildlife and Marine Resources Department, Columbia, SC.

Hopkins, Sally. "From Field to Forest." S.C. Wildlife. S.C. Wildlife and Marine Resources Department, Columbia, SC. Volume 22, No. 3, May-June 1975.

Jacobsen and Wilson. Food Scoreboard. Center for Science in the Public Interest, Washington, DC, 1974.

Lappe, Frances Moore. Diet for a Small Planet. New York, NY: Ballantine, 1975.

McCombs, Lawrence W., and Nichols Rosa. What's Ecology. Reading, Massachusetts: Addison-Wesley Publishing Co., 1973.

Miller, G. Tyler. Living in the Environment, Concepts, Problems, and Alternatives. Wadsworth Publishing Company, Belmont, California 94002. 1975.

Morton, Julia. Folk Remedies of the Lowcountry. Miami, Florida: E. A. Seemann Publishing Company, 1974.

NSTA. Interdisciplinary Student/Teacher Materials on Energy, The Environment, and The Economy. Agriculture, Energy, and Society. ERDA. Washington, DC 20545 (free).

Office of Communication. From the Earth to Your Table, An Activity Master Program About the Economics of Food. U.S. Department of Agriculture. Washington, DC 20250. Other pamphlets from this office include: The Real Facts About Food, Agriculture U.S.A., Foreign Trade Series: "What Farm Exports Mean to You," "What Makes U. S. Farm Trade Grow," "What Our Farm Exports Mean to the World," "How U. S. Farm Exports Have Grown," "Who Buys Our Farm Products."

Scientific American. S. C. Department of Agriculture. South Carolina on the Move (film). September 1976.

Simon, Arthur. Bread For The World. Paramus, New Jersey: Paulist Press.

Simulation Game (Third World).

S.C. Forestry Commission. Plant and Animal Communities - Ecological Succession

Important Trees of Eastern Forests

Leaf

Familiar Trees of South Carolina

Knight, Herbert S.C.'s Timber Resources

Extra Forest Dollars (Film)

Ten Lessons in Forestry

Time Lapse Studies of Growing Trees

Trees for Polluted Air

Forest Murmurs (Film)

Report of the State Commission of Forestry for the Year 1975-76

The Eternal Forest (Film)

Indian Valley Forest Management Game

Forest Insects and Diseases

S.C. Land Resources Dept. Forest and the Natural Water Cycle

The Role of Trees in Reducing Pollution

Sediment

Controlling Erosion on Construction Sites

S.C. Wildlife and Marine Resources Dept. Carolina Heritage (Film)

"Francis Marion's Forest." S.C. Wildlife. November-December 1976.

The Gifts

"Stripping the Forest Bare, Why all the Furor." U.S. News and World Report. May 31, 1976.

Stokes, Bruce. Local Responses to Global Problems: A Key to Meeting Basic Human Needs. 1978, 64 pages.

Succession, From Sand Dune to Forest. USC.

281

"The Nation's Greatest Success Story." U.S. News and World Report. May 31, 1976.

"The Revolution in American Agriculture." National Geographic. February 1970.

USDA. From the Earth to Your Table. Office of Communications, USDA, Washington, SC 20250 (Free).

Washington State Office of Public Instruction, Office of Environmental Education. Energy, Food and You.

Worldwatch Paper Series. \$2.00 each, Worldwatch Institute, 1776 Massachusetts Ave., NW, Washington, DC 20036.

THE SALT MARSH

Along the coast of South Carolina are green, wet places connected to the sea by tidal creeks. These are the salt marshes. Twice each day the marsh is flooded by tides. The environmental conditions in the marsh are harsh and organisms must be adapted to these conditions.

Scientists have found that the salt marsh, once considered useless, is some of the most valuable land in the state. It is a unique and invaluable ecosystem. Tons of nutrient-enriched materials washed from the uplands accumulate with still richer oceanic nutrients carried in on the tide to lay the foundation for a habitat of unequaled food reserves.

Most marine life is directly or indirectly dependent on the salt marsh. Some species live and spawn in the sea as adults, but come into the shallow productive waters of the tidelands to mature. Others enter the protected waters to spawn or to feed in the summer. For this reason, the salt marsh is called the "cradle of the sea." Many species, of course, spend their entire lives in the marsh. It is the home and feeding grounds of countless waterfowl and small mammals, in addition to the many amphibians and reptiles.

The variety of life and the natural stability of the salt marsh is of priceless value to man. It provides fish nursery grounds, is the source of shellfish, provides protection from flood and storm damage, and is a cleansing agent in the water cycle.

CONTENT

The salt marsh is a constantly changing ecosystem located along our coast.

A salt marsh is divided into several zones; each zone has its own physical and biological characteristics.

STUDENT OBJECTIVES

The student will be able to:

Describe salt marsh.

Locate all South Carolina salt marshes on a map of South Carolina.

Draw and label zones of a salt marsh.

Describe the salinity of the environment of each zone of a salt marsh.

STUDENT ACTIVITIES

View the "Thin Green Line" and discuss.

Using a blank map of South Carolina, shade in with pencil the area where you think the salt marsh is located. Compare with a marked map of South Carolina and correct your maps if necessary. (See p. 147.)

Draw and label the zones of the salt marsh. Briefly describe the physical environment of each zone, telling how the temperature, salinity, light, oxygen availability limit what can be found there.

Using the list of organisms on p. 182, do written research on one organism of the marsh. Include answers to the following questions:

- Where does the animal or plant live (habitat)?
- What does the organism eat, and what eats it?
- What special characteristics does the organism have for coping with its environment?

RESOURCES

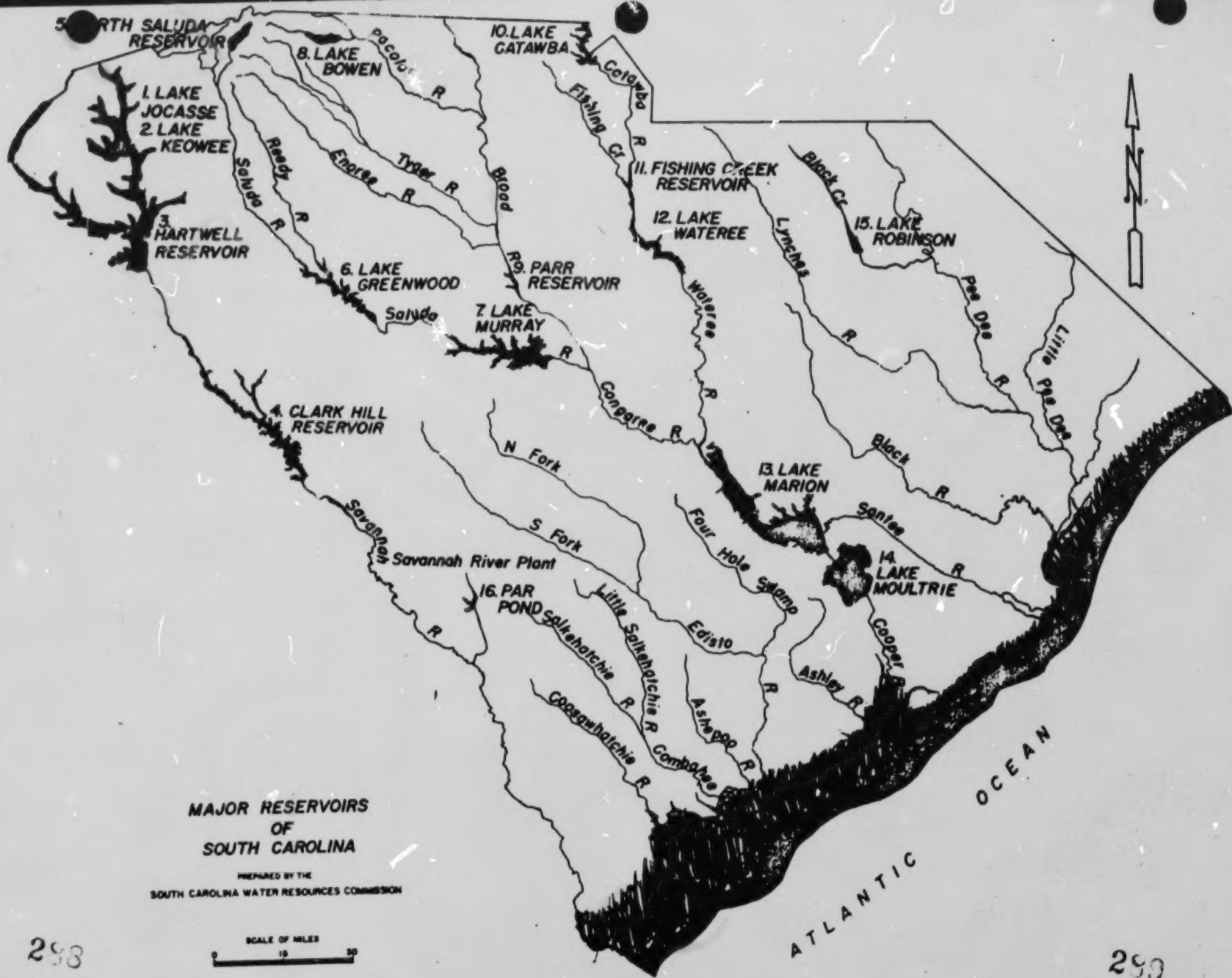
Film: "The Thin Green Line" from South Carolina Wildlife and Marine Resources Department.

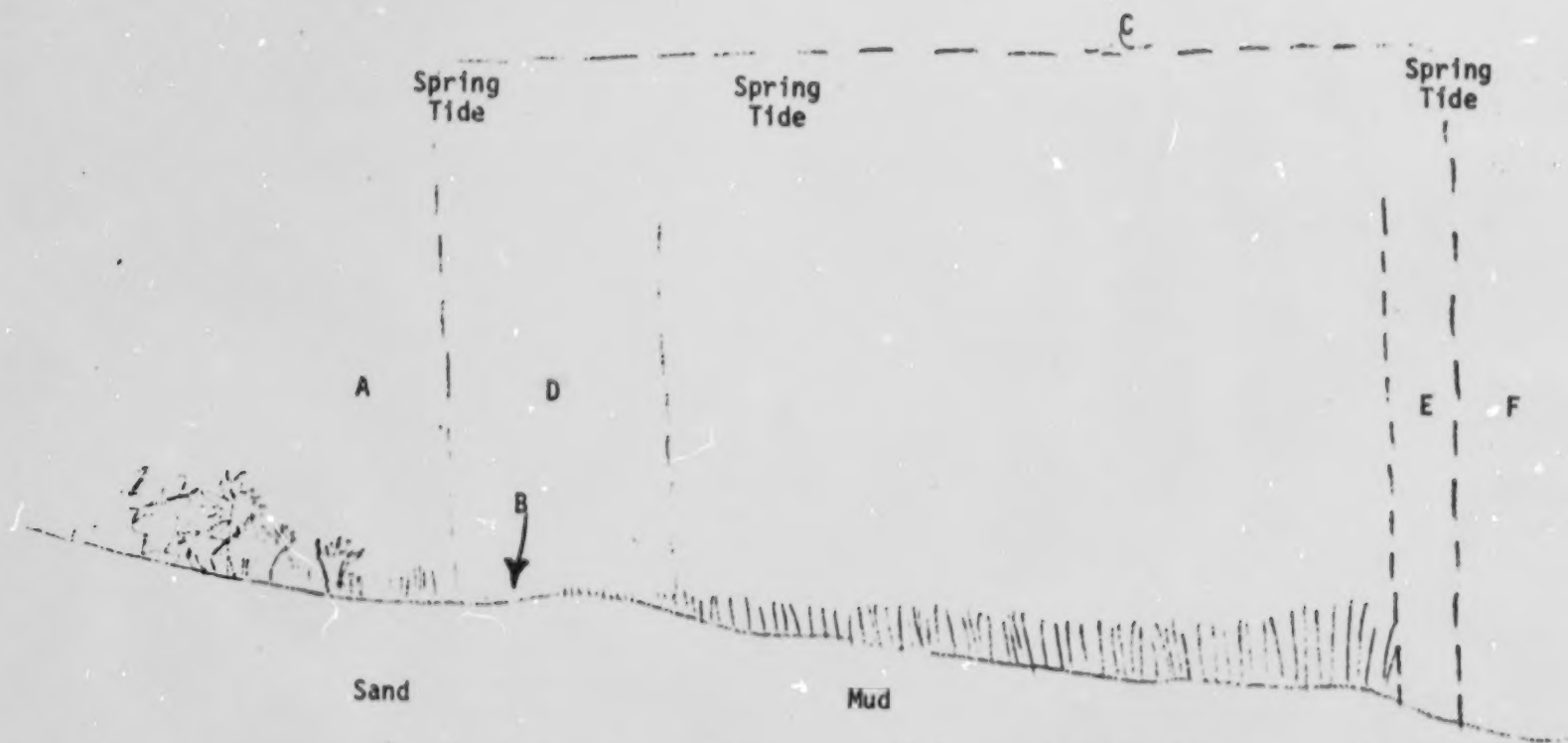
Reproduce a map of South Carolina.

Teacher: see page 148.

Laurie, Pete, "Salt Marsh and Estuaries," South Carolina Wildlife, March-April 1975.

Page 182-184.





Zones:

- A. Supertidal Zone
- B. Salt Barren
- C. Intertidal Zone
- D. Upper Intertidal Zone
- E. Lower Intertidal Zone
- F. Subtidal Zone

290

291

CONTENT

STUDENT OBJECTIVES

The student will be able to:

Know 3 organisms of each zone and the following things about each organism: habitat, role in food chain, life cycle, value.

STUDENT ACTIVITIES

d. What is the life cycle of the organism? Use a diagram if possible.

e. Draw a food web including your organism. (See p. 151.)

Report findings to the class. Each student may fill in the following chart.

Organism	Eats	Is Eaten By
1.		
2.		
3.		

Play "I've Got a Secret." (rules follow)

Rules: The person who is "it" chooses an organism of the salt marsh (could be the one the student did the report on). He then gives the class one fact about the organism, which can be a very obscure fact. The members of the class try to guess the name of the organism by asking very specific questions such as "Are you big as compared to a dog?", not just "Are you big?" All the questions must be answerable by a "yes" or "no." The person or team who guesses correctly first gets a point.

Construct a crossword puzzle or other word game reviewing your organisms.

RESOURCES

CONTENT

Energy in the salt marsh is transferred through a food web.

The salt marsh is an economically valuable resource.

STUDENT OBJECTIVES

The student will be able to:

Know the following: food web, food chain, producer, consumer, herbivore, carnivore, omnivore, decomposers, detritus.

Describe a food chain in the marsh and develop these food chains into a food web.

List economic benefits of a salt marsh.

STUDENT ACTIVITIES

Take a field trip to a salt marsh. Keep accurate records of all observations that your group makes. Follow the field trip guide for the marsh and the laboratory.

Set up a salt water aquarium in the classroom when returning from the field trip.

Carefully work through the student activity package on Energy Flow Through the Salt Marsh. Gather information from the audiovisuals, resources in the classroom library to fill out your package. See pages 167-169 for a copy to be reproduced.

View "The Salt Marsh: A Question of Values" and/or "Estuary" and make a list of the economic benefits of the salt marsh. Discuss other benefits which may not be economically related.

RESOURCES

Page 155-166

Page 170-172.

Reproduce page 167-169. for each student.

Food Web: page 151.

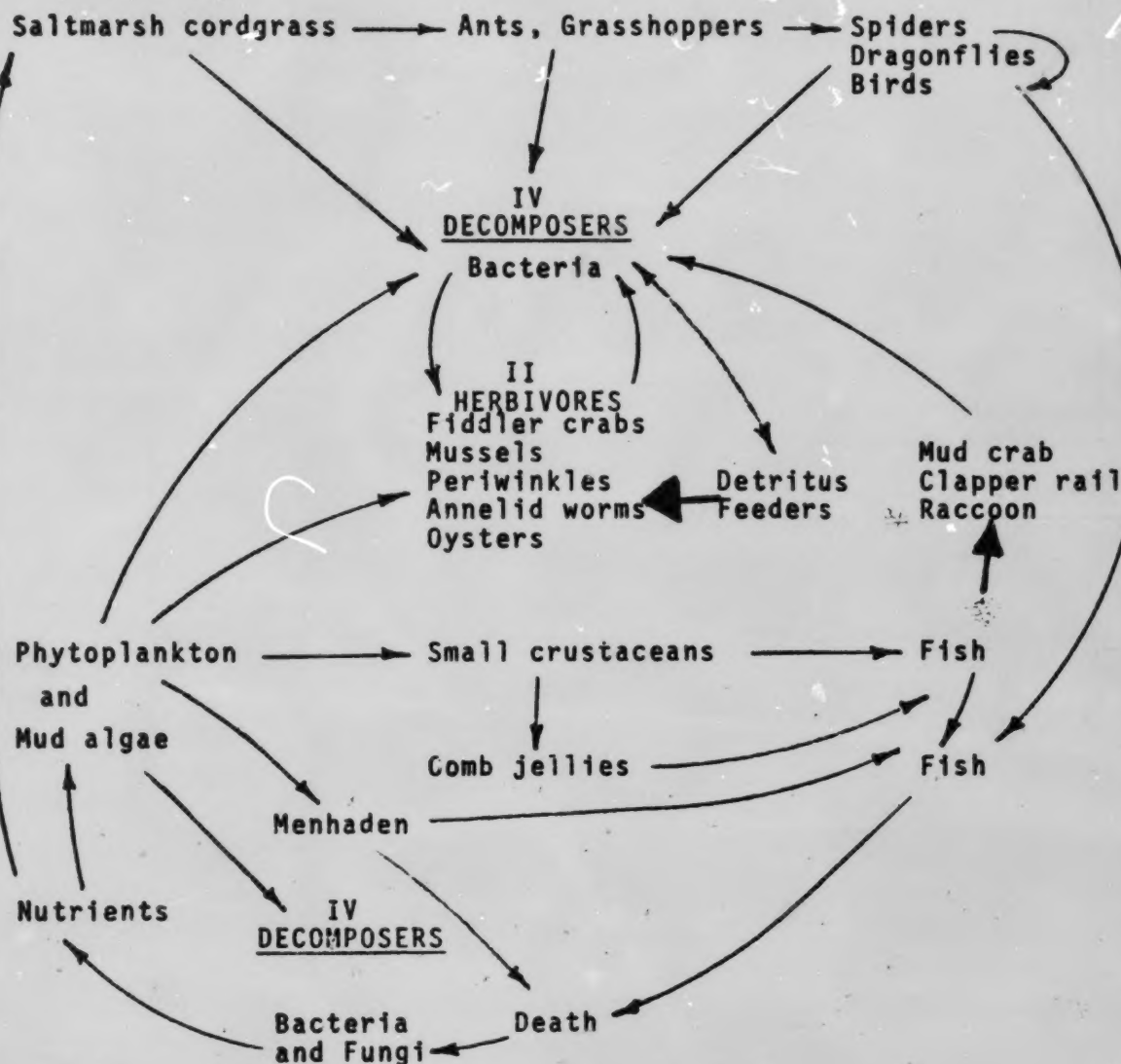
Films: "The Salt Marsh: A Question of Values," "Estuary"; refer to 179 for source of films.

TIDAL SALT MARSH FOOD WEB

I PRODUCERS

II HERBIVORES

III CARNIVORES



CONTENT

Environmental changes have an impact on the salt marsh.

STUDENT OBJECTIVES

The student will be able to:

Explain how changes in a salt marsh can affect that ecosystem.

STUDENT ACTIVITIES

Organize and conduct a simulated public hearing.

Simulation of Public Hearing:
A proposal has been put before the town council of Murrell's Inlet, South Carolina, to fill in the salt marsh to provide land to build a recreational park providing a Pony League baseball field, picnic tables and grills, a swimming pool, tennis courts, children's playground, and a multi-purpose area for volleyball, horseshoes, etc. You are a _____ and want to present your views at this hearing.

Teacher Note: Fill out a small card with one of the following roles or others and possibly some information on that role. Give the students time to research their role carefully before holding the hearing. Roles: shrimp boat owner, restaurant owner, motel owner, resident of the area, deep-sea fishing boat owner, oyster gatherer, representative of the Army Corps of Engineers, representative of the Environmental Energy Protection Agency, marine biologist, representative of South Carolina Parks, Recreation and Tourism, hunter, representative of the South Carolina DHEC office, etc.

RESOURCES

Wastewater Bureau of DHEC: assistance for public hearing format.

CONTENT

There is current legislation providing some protection for the tidelands.

Other agencies are working to educate the public, and to protect and preserve the salt marsh.

Individuals need to take a position in regard to salt marsh management.

STUDENT OBJECTIVES

The student will be able to:

List destructive forces acting on the salt marsh.

Name three locations of salt marshes which have been posted due to pollution.

Know what the major points of current legislation concerning the salt marsh are.

Name three agencies that are working to preserve the salt marsh and what each is doing.

Express his opinion on salt marsh management.

STUDENT ACTIVITIES

Write a letter to the South Carolina DHEC and find out which salt marsh areas are posted and try to find out the reasons.

Read the synopsis of the Tidelands Bill of 1977. Express the major points in a paragraph.

Write to an agency which deals with the salt marsh. What is being done in regard to salt marsh management? Study your information and present your findings to the class. Are we doing enough?

View the slide presentation and pose questions to a representative of the Office of Coastal Planning, Charleston, South Carolina.

RESOURCES

Refer to 173.

Refer to 179.

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

In order to show your position, place yourself, along with the rest of your class, on the following physical continuums.

Teacher Note: For instruction, see Values Clarification.

Salt Marshes:	Save All
What are they?	Salt Marsh

Wasteland	Paradise
-----------	----------

Valueless	Priceless
-----------	-----------

RESOURCES

FIELD TRIP TO A SALT MARSH

1. Extensively adapted from Taylor, Beth, and Will Hon. The Field Approach to Coastal Ecology. Carteret County Regional Marine Science Project, Carteret County Schools, Beaufort, North Carolina.
2. Divide the class into three groups. The duties of each group should be as follows:
 - Group I: Physical characteristics of the salt marsh. They will also lay the transects for stations worked by groups II and III.
 - Group II: Producers of the salt marsh.
 - Group III: Consumers of the salt marsh.
3. Group I: Divide this group into 3 subgroups.
 - a. Subgroup A should put a stake in the ground at high tide mark. As the tide recedes, they should put stakes in the ground at 5 or 10 meter intervals until low tide. The tops of all stakes should be at least as high as the bottom of the high tide stake. A string will be stretched along the stakes when the tide is out.
 - b. Subgroup A should stretch a string along their stakes from high tide to low tide. The string should be level. A sighting level can be used to level the string.
 - c. Two members of the group should measure the distance from the string to the ground at 1-meter intervals from the supratidal to the low water mark. They should plot their measurements on graph paper to develop a profile of the study area. Four stations for sampling should be assigned in the supratidal, high intertidal, low intertidal, and subtidal regions of the transect line. The stations should be marked on the profile.
 - d. Subgroup B should measure the temperature and time of exposure of each zone. They should make the following temperature and exposure-time studies:
 1. Measure the temperature of the air at a height of 10 cm. above the ground, on the surface, and at a depth of 3 cm. below the surface of the ground. The subsurface temperature may be obtained by gently working the tip of the thermometer into the soil. The 3 cm. depth is not critical. Most thermometers have a ring a few centimeters above the bulb. Pushing the thermometer into the ground to the level of this ring is sufficient. The essential thing is uniformity in depth of measurement. The same goes for the 10 cm. of the air measurement.

2. If ghost crab or fiddler crab burrows are present, the thermometer should be placed as far down the burrow as possible for a temperature measurement.
 3. One set of measurements should be made at supratidal, high intertidal, and low intertidal stations as soon as they are exposed by the falling tide.
 4. The time of emergence of each station from the water should be recorded.
- e. One member of Subgroup B should put a thermometer on the surface and in the ground to the 3 cm. mark at each station as it emerges from the water. This team member should read the temperature of both thermometers at each station as soon as it emerges from the water. A member of the subgroup should be stationed with each pair of thermometers for the duration of the activity. They should read the surface and subsurface thermometers each 10 minutes--at closer intervals if the temperature is changing very rapidly, such as on a hot spring day. These measurements do not have to be made on the actual transect line. They may be made off to one side but in parallel with each sampling station.
 - f. Subgroup C should measure the salinity of the water. They should use a salinity refractometer or whatever other method is available.

Samples should be taken at each station just before the water leaves it. At low tide, salinity samples should be taken as the tide rises again. Sampling should be stopped at low water mark when the water becomes uncomfortably high. Directions for measuring salinity are enclosed with the particular instrument used.

4. Group II will sample the producers of the area. Divide Group II into the following subgroups:

Subgroup A: Producers of the supratidal.

Subgroup B: Producers of high intertidal.

Subgroup C: Producers of the low intertidal (mud flat).

Subgroup D: Producers of the subtidal.

- a. Subgroups A-C should each receive the following items of equipment:

3 trowels
1 meter-quadrat string
10 plastic specimen bags
1 meter stick

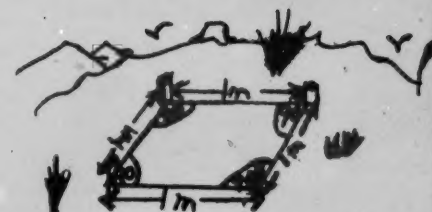
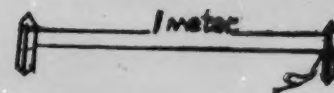
Subgroup D should be equipped with:

a plankton net
plastic specimen bags
small jars

A meter-quadrat string is easily made by tying a 5-meter string to a stick. Stretch the string out to one meter. At the one meter mark, tie on another stick. At similar 1-meter intervals, tie on two more sticks. The remaining string should be tied to the initial stick at a distance of one meter from the last stick. The assembly of string and sticks may be placed on the ground as a square. (be sure to get 90° angles!) containing exactly one square meter. Plants and animals may be counted in this square to determine a quantitative estimate of the abundance of various species of plants and animals in the square. The construction and use of the quadrat string is shown in figure 1.

- b. Subgroups A-D should go to their appropriate stations on the transect line. The sampling should be done using the transect string as a midline for the square-meter quadrat.
- c. Subgroups A-C should set up their quadrat strings to count the plants in one square meter of soil under the string. They should count all plants for a total number of plants in one square meter and also individual numbers for each type of plant they can distinguish.
- d. The height of the various species of plants in the quadrat should be measured. A sample of five or ten should be measured for each species if that many are found in the quadrat.
- e. The group should collect one or two plants of each kind for identification in the lab. They may be collected with the trowel and put in plastic bags with a little soil.

As much as possible of the root system should be taken. They should note how far beneath the surface the root system begins. If it is buried beneath a few inches of soil, it may have acted as a trap for wind or waterborne particles and helped to build up the marsh or dune in which it is found.



- f. When subgroups A-C finish their transects, they may be assigned to count quadrats in the higher levels of the marsh if the vegetation is noticeably different.
 - g. All stations on the transect should be plotted on the profile drawn up by Group I. Their distance from each other and their varying elevations can be taken from the profile.
 - h. Subgroup D should take a plankton sample with a fine plankton net in the subtidal zone. This will serve as a sample of planktonic producers of the marsh and local estuary.
 - i. If the area of your field trip is known for abundant rooted algae in the subtidal zone, be sure that members of subgroup D examine the dredge samples of Group III.
5. Group III will sample the consumers of the marsh - the animals.
- a. Divide Group III into four subgroups as follows:
 - Subgroup A - animals of the supratidal
 - Subgroup B - animals of the intertidal
 - Subgroup C - seineable animals of the subtidal
 - Subgroup D - dredgeable animals of the subtidal

Directions for use of the seine and dredge are located in the beach zonation exercise in the section, "Where do we find life in the sea?"

- b. Subgroup A should be given a shovel and plastic bags. They should roam to either side of the transect line, digging animals out of holes, checking through masses of seaweed and under other objects on the beach, and otherwise looking for animals in the supratidal. Supratidal species may be somewhat scarce. The collectors should wander fairly far to either side of the transect line.
- c. Subgroup B should be equipped with a shovel, sieve, and plastic bags. They should work the high intertidal and low intertidal quadrats set up by Group II.
- d. Members of subgroup B should dig up portions of the quadrat and put them in the sieve. The sieve should be taken to the water and jostled about to remove the mud from the animals.

Specimens obtained by sieving should be put in strong plastic bags with enough water to cover the animals by a centimeter or so. The bag should be closed by twisting from the top. As the twisted portion grows longer, the bag should belly out from trapped air. This air will increase the amount of gas exchanged to animals in the water.

- e. Someone should collect a handful of mud from each quadrat and put it in a bag with enough water to cover it. By the day after the field trip, many small animals should have moved from the mud to the water. DO NOT ADD FORMALIN TO THIS BAG!
- f. The sampled area should be measured for width, length, and depth. This will enable quantitation of contained fauna by area and by volume of mud.
- g. Subgroup C should seine the subtidal to obtain samples of animals living on the surface of the bottom and swimming in the water. They should seine against the prevailing current. This procedure will keep the seine in a pocket formation which will keep animals in the net.

The group should seine two or three times in a line perpendicular to the transect line.

- h. Subgroup D should dredge the bottom of the subtidal to obtain samples of animals lying flat on or buried just under the surface of the bottom. The dredging should also be done against the prevailing current.
6. At the end of the exercise, all plants and animals should be in plastic bags. A profile of the marsh should be complete with the stations plotted on it. Salinity, temperature, and times of immersion should be available for each station.

If any of the equipment is muddy, the mud should be washed off in the water. On return to the school, all equipment should be rinsed in fresh water.

A sample of each kind of organism on the marsh and mud flat should be preserved. Five percent formalin is good for invertebrates. Ten percent formalin should be used for fish. Use a scalpel to put 1-2 centimeter slit in the abdomen of any fish over 3-4 cms. in length. The cut will allow the formalin to enter the abdomen to preserve the internal organs.

All large plants should be mounted on herbarium paper. Plant and animal plankton should be preserved in 5 percent formalin.

The animals which remain alive should be put in the marine aquarium in the classroom as soon as the class returns. Put only a few of each kind in the aquarium, being careful not to overcrowd.

Divide the class into two groups. They will work with the following organisms:

Group I - Producers of the salt marsh

Group II - Consumers of the salt marsh

Group I should divide themselves into two groups:

Subgroup A - Producers of the plankton

Subgroup B - Osmotic relations and rooted producers

The group as a whole should discuss the biblical quotation, "All flesh is grass" before beginning work. Guide the discussion to get the students to deal extensively with the consumption of plants by animals.

7. Subgroup A will study the producers of the plankton obtained from the subtidal zone. Equip them with microscopes, slides, coverslips, droppers, paper towels, lens paper, and the plankton samples. They may then study the plankton in the following manner:

- a. Reach into the bottom of the plankton organisms to a clean slide. Put a cover on the slide.
- b. Observe the plankton organisms, using the low power lens. Count the diatoms present, and any green dinoflagellates which appear. The members of the group should answer the following questions:
 - A. Do you see any diatoms that look like the pictures you have seen of these organisms? _____
 - B. How many kinds do you see? _____
 - C. Do a quick sketch of each type of diatom you see and tell how many you have found.

8. Subgroup B will work with the rooted marsh producers. They should have the following items on hand:

- a. osmometer
- b. concentrated salt solution
- c. distilled water
- d. dye (any water-soluble dye)
- e. rooted plants obtained from the tidal transect

9. Various members of subgroup B should carry out the following procedures:

- a. Fill the bag of the osmometer with distilled water to which enough dye has been added to produce a reasonably dense color.
- b. Fill the cup of the osmometer with the concentrated salt solution.
- c. Assemble the osmometer. Mark the water level in the tube.

One member of subgroup B should be assigned the task of watching the osmometer to alert the rest of the group to any changes which occur.

10. Changes should begin to occur in the osmometer within a short time. Other members should begin plant identifications (Step 11). The subgroup should then be able to answer the following questions:

- a. Did a color change occur? _____
- b. Where, and in what direction? _____
- c. What have you learned from this exercise about movement of fresh and salt water? _____
- d. Your body cells contain salt at a concentration of 9.0/00. What would happen to you if you were lost at sea and drank salt water? (35 parts per thousand) _____
- e. Apply the same principle to plants. They also possess relatively low salt concentrations but live in high-salinity environments. What sort of basic problem is faced by these plants? _____

11. During the time the osmometer is operating, subgroup B should be identifying the rooted producers obtained from the quadrats on the previous day's field trip.

For each quadrat, a list should be made of the species and plants found and the numbers in which they occurred.

12. The number of species and number of plants of each species present in each quadrat should be plotted on the beach profile obtained on the field trip the previous day.

13. At this time, it may be desirable to make a larger copy of the profile for class display. One or two members of the class may be given the task of making a profile poster on a large piece of poster board. If desired, small herbarium mounts of the principal species at each station can be pasted to the large profile chart. They may be arranged in natural groupings to represent the plant communities at each station.

14. The dominant factors in the environment of the marsh plants are salinity and time of immersion. The members of the subgroup should examine the diversity of species and sizes of the plants at each station and try to reason why a particular species is found where it is.

An example of the questions they may ask themselves is, "Why are there no algae in the supratidal?" The answer is that they dry out when exposed. Some algae can withstand lengthy periods of emergence. Many more algae can withstand short periods of being left behind by the falling tide, other species can live submerged at all times. This is the reason for looking at the numbers of species of plants at each station. If a significant number of algae are found, the students should examine them to find differences which might signify adaptations to differing periods of dryness.

Intertidal algae may be regarded as plants that are invading the land from the sea. They must adapt to periods of dryness.

Plants with true roots, stems, and leaves, such as cordgrass (Spartina) or burrweed (Borrchia) represent the reverse situation. They are terrestrial plants invading the margins of the sea. The students should look for adaptations to the high salinity and other conditions of the marsh. Life and Death of the Salt Marsh will serve as an excellent reference for these adaptations.

15. Group II will work with the consumers of the salt marsh. Divide into subgroups with the following areas of investigation:

Subgroup A - Animal behavior

Subgroup B - Distribution of marsh consumers

16. Subgroup A should work with the living animals obtained from the previous day's field trip. Among the animals they probably found are:

Oysters

Mud snails

Marsh periwinkle snails (from the marsh grass)

Fiddler crabs

Mud crabs

Shore crabs

Mussels (small to large black, ribbed bivalves)

Small animals (contained in the mud sample;
taken on the field trip)

17. Equip subgroup A with several finger bowls, a little bit of carmine, and hand lenses. Stereomicroscopes will be helpful if they are available.

18. Subgroup A should take the live specimens from their bags and put each kind in a separate finger bowl of seawater. They should observe the animals to answer the following questions:
- Which of the animals are most closely related?
 - What are the reasons for their answers?
19. Oysters and mussels are filter feeders. One of each kind should be opened. The shell half which contains the animal should be placed in a finger bowl half full of clean seawater. Use separate finger bowls for each specimen.
20. The experimenters should sprinkle the exposed oyster and mussel with a bit of carmine powder and observe the animals to answer the following questions:
- What happens to the carmine particles?
 - Why do you think this is happening? (Answer: The animals are eating the particles)
 - Does either animal have a mechanism for sorting out the particles?
 - What sort of feeding relationship probably exists between the oyster and the surrounding seawater, particularly the plankton?
 - Is there any noticeable difference between patterns, rates, or other aspects of particle movement between the oyster and the mussel?
 - Do you notice anything different in the methods by which the oyster and the mussel attach themselves to the substrate?
21. The students should observe a fiddler crab and some other crabs in finger bowls of seawater. They should answer the following questions:
- How do these crabs differ? In body form? In behavior?
 - Look at the claws of the various crabs. Are they any different? How about the legs?

22. The students should cut up an oyster or mussel and offer bits of it to the crabs. If any shrimp are handy, pieces of these may be offered. The feeding behavior of the animals may be observed, and the students should try to answer the following questions:
- Does the crab accept the food?
 - Does he grab it fast, or relatively slow?
 - How does he handle it?
 - Do the crabs seem able to handle extremely fine particles, such as the oyster and mussel handle?
 - How do you think the feeding habits of crabs and the oyster and mussel differ?
23. The students should observe the mud snails and marsh snails in finger bowls half full of seawater. The students should try to answer the following questions:
- What are the difference between the two kinds of snails?
 - Does either of them come to the surface or crawl out of the water?
 - Which one?

Visit the table when they have found the marsh periwinkle snail (Littorina) out of the water. Ask, "What is the most available high structure for Littorina to climb as the tide rises?" (Answer: Marsh grass.) Ask them, "Where do you think you would find this snail at high tide?" (Answer: Clinging near the exposed tops of marsh grass.)

24. One or two students should pour the supernatant water from the field trip mud sample into a dish. They should examine the dish with a hand lens or stereomicroscope (if available) to see how many different kinds of animals can be found in the mud.
25. Subgroup B should mostly occupy themselves with identifying the preserved animals from the transect. They should develop species number and animal lists (#species/#animals - diversity) just as the producer group did.
26. Subgroup B may also wish to develop a poster-sized chart of the marsh profile just as Group I did.

27. The subgroup should look for adaptations to the different tidal zones of the marsh to answer the following questions:
- a. How does the diversity of the marine animal population differ in the different tidal zones?
 - b. How do the types of animals differ? (For example, one finds no fish in the supratidal. Among the crustacea, few kinds of shrimps will be present at low tide, but several kinds of crabs may be found.)
28. At the end of the exercise, both groups should report their results to the class as a whole. One convenient way of handling their reports is to have one member of each subgroup report for the subgroup.
29. When the reports are finished, the class will construct a chart of the salt marsh ecosystem. This chart should show the most important producers and consumers of each tidal zone.

Field Trip Follow-Up Activities

Set out reference books for identification of the organisms. Some handy volumes are listed below. Asterisks (*) designate most essential volumes.

*Abbott, R. T., 1968.

Seashells of North America.

Golden Press, New York. A standard guide.

*Dawson, E. Yale.

How to Know the Seaweeds.

William C. Brown, Dubuque, Iowa. An excellent, profusely illustrated layman's guide to the algae commonly known as seaweeds.

*Zim, H. S., and H. H. Shoemaker, 1955.

Fishes, A Guide to Fresh and Saltwater Species. Golden Nature Guides, Golden Press, New York. Usually available at local bookstores. The scientific names of the fishes are listed in the back of the book. A very nice first book of the fishes.

*Zim, H. S., and L. Ingle, 1955.

Seashores. Golden Nature Guide, Golden Press, New York. A good inexpensive guide for general identification of seashore plants and animals. Scientific names are given in the back of the book.

Breder, C. M., Jr., 1948.

Field Book of Marine Fishes of the Atlantic Coast. G. P. Putnam's Sons, New York. This is a higher level book with a key to almost all marine fishes found on the Atlantic Coast. If a fish is not in the Golden Field Guide, Fishes, it is probably in Breder.

Pratt, H. S., 1948.

A Manual of the Common Invertebrate Animals. Blakiston Company, Philadelphia. A more advanced invertebrate book. Very good for students who wish to pursue the identification of any animal not found in Zim and Ingle.

Radford, Ahles, and Bell, 1968.

Flora of the Carolinas. A profusely illustrated key to the plants of the Carolinas, including the marsh and beach plants. Almost any wild plant can be identified with this book. It is fairly technical, but perusal of the introductory material in front should enable the more knowledgeable students to do quite well on their identifications.

Student Activity Package on Energy Flow Through the Salt Marsh

Energy can enter the food web of the salt marsh from several sources. The shallow bays associated with salt marshes often support an abundance of life. Trace the energy flow in one of these productive areas.

One group of producers found in these marshes are the sea grasses. The predominant producer in South Carolina is Spartina, salt marsh cordgrass. Some people view marshes as wastelands, only useful if filled in and developed with waterfront homesites. After tracing the energy pathways in the marsh, see if you can come up with some reasons why salt marshes should be preserved in their natural state.

The major energy source for the salt marshes is the (sun).

This type of energy is not directly useful to most marsh organisms. What type of organisms can use this solar light energy? (producers)

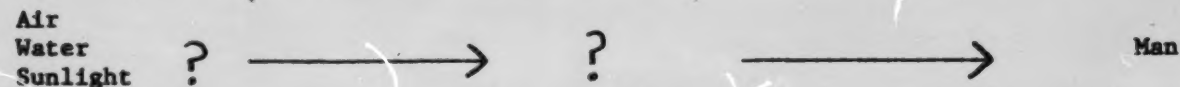
They are able to convert light energy to chemical energy through the process called (photosynthesis).

List all the producers you have studied or seen on your field trips.

Few animals feed directly on the grasses, however a great many animals find shelter and protection among the grasses. Others feed on the algae that grows on the leaves or in the mud around the grasses.

One animal that feeds on algae is the mullet. Because it is a plant eater, the mullet is classified as a (herbivore).

Draw the food chain that results when man eats the mullet.



This shows how man obtains energy from the marsh.

Next, list the herbivores you observed or studied.

Most of the grass on the flats dies without being eaten. This dead grass is attacked by (decomposer) organisms. The dead grass along with its attached bacteria and fungi (decomposer) make up a protein-rich energy source known as (detritus).

Most of the organisms in the salt marsh are dependent on this detritus as their connecting link to the energy from the sun.

Fill in the following steps in the detrital energy pathway.

Sunlight _____ Salt marsh
cordgrass _____

The pathways of energy flow in the marsh are intertwined. These energy pathways form a marsh food web.

The mid-level carnivores in the marsh are generally fish and crustaceans. What do these feed on? (list)

Another large marsh organism that we have left is man (omnivore). List some of the marsh organisms that people use as food.

Construct a food web and show the energy flow through the organisms of the salt marsh. You begin with a (producer), then add: (herbivore), (carnivore), (omnivore), and (decomposer). Don't forget detritus. Use as many organisms as you can recall (at least 10).

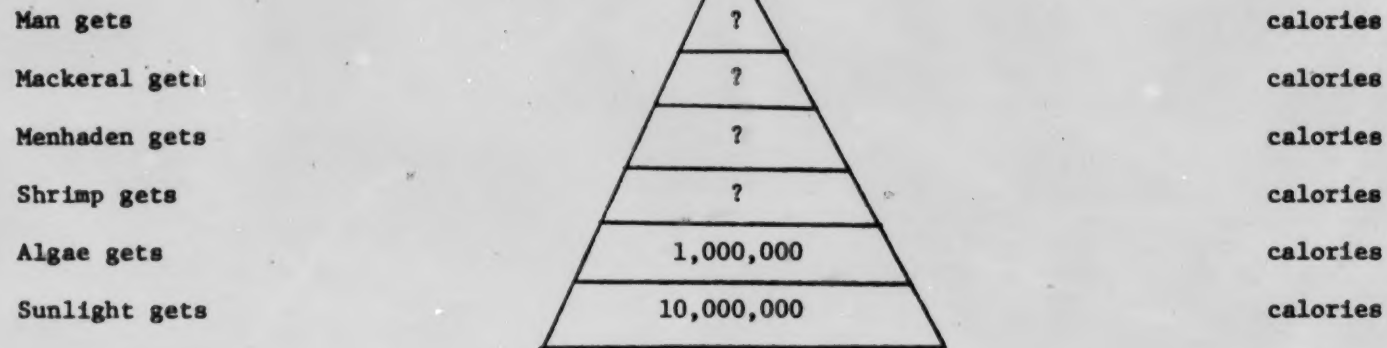
Now that you have determined the pathways of energy flow in the salt marsh, look at the efficiency of this flow. In any energy transfer, some of the energy is lost to the system as heat. This means that energy transfers are always less than 100% efficient. As a rule of thumb, about nine-tenths of the available energy is lost with each transfer in the marsh food web. This means that as we move up a food chain, there is less and less energy available at each successive level.

How do you think this energy is lost?

Basically, the energy is lost to each succeeding level in three ways:

1. All the organisms in a food (trophic) level are not utilized by the organisms in the next level up.
2. The organisms that are used for energy have already converted some of their stored chemical energy to heat energy for growth and repair of their bodies.
3. Organisms are not 100% efficient at digestion, so some of the potential energy of the ingested food is lost as waste matter.

If we look at this as a pyramid, we see the following relationships. See if you can fill in the missing numbers.



Making a Salt Water Aquarium

CONTAINER

For the beginner, a variety of plastic containers can be used. A one-gallon pickle jar can make an inexpensive aquarium; however, images may be distorted due to their round sides. Plastic containers can also be used. In setting up a salt water aquarium, care must be given to the possibility of introducing metallic ions into the tank from the metal frames of the standard fish tank. If purchasing a new aquarium, an all glass or plastic tank is preferable. The standard stainless steel and glass tank can be used by fitting the tank with a glass cover which hangs from brackets and is recessed within the borders of the top frame.

WATER

Anyone in any part of the state can set up a salt water aquarium. Sea-salt formulas are readily available and many companies now offer "ready-mixed" salts which contain all of the essential elements in their proper proportions and which produce a servicable natural salt water substitute. Synthetic salt water lacks one essential ingredient of a thriving, healthy, marine ecosystem — an abundance of microscopic organisms and other organic materials. It would be advantageous to add natural sea water to your system on occasion or to use the sea water exclusively. It is wise to mark the water level on the side of the tank in order to determine how much water has been lost through evaporation. Water lost should be replaced with tap water or rain water. (If replaced with salt water, the salinity would be too high.) When obtaining sea water, it is best to use all plastic containers. Water can be placed in plastic garbage sacs placed in trash cans. These should not be used for anything else — paint, garbage, pesticides, etc. If washed, make sure they are rinsed adequately. It is best to allow the sand and silt to settle to the bottom of the bucket before pouring it into the larger container.

SUBSTRATUM

Coarse sand, fine gravel, crushed oyster and clam shells are preferred by some as a substratum. Sand can be used but there is a tendency for material in the sand to decay. A few strategically placed rocks upon which the inhabitants can attach themselves, hide, or forage will lower the possibility of decay if sand is used. Two criteria in the choice of a substratum are the ease with which it can be kept clean and the type of habitat it offers specimens.

FILTERS

Filters can be either "natural" or mechanical. Clams, mussels, barnacles and sea anemones are natural filters. These organisms can be starved to death by an over-efficient mechanical filter. If a filter is used, a sub-sand or gravel filter is best. Water is continuously drawn through the gravel which acts as a filter. Bacteria living among the grains bring about the decomposition of this material and promote the return of decay products to the normal cycle of the system.

ORGANISMS

Organisms taken at moderate depths in local waters will survive at room temperature. If there is a great difference in the temperature of the environment and the tank, the organism should be acclimated by floating it in a plastic container filled with its natural cold water in the tank for an hour or two. A fish tank heater should not be used because decay will contaminate the entire system.

AERATION AND LIGHT

The tank needs to be aerated. The simplest device is an electric vibrator which operates a bellows that drives a stream of air through an "air stone" or "air breaker." If the tank has a relatively large water-air interface (most rectangular fish tanks do) the oxygen content of the water will be high enough. An advantage of an aerator is that it will carry off the accumulated carbon dioxide. This helps maintain the normal pH of about 8.2. An aerator also sets up currents that stimulate the feeding responses of such organisms as barnacles and reduces the chances of formation of local pools of pollution. A light can and should be used; however, it is important to establish a balance between the amount of light and its effect on the temperature.

FEEDING

Do not overfeed the organisms in your tank. (Keep in mind that most of the organisms your tank will house can go without food for over a month.) Overfeeding occurs when the rate of decay exceeds the rate of food consumption. The first sign of this condition is a cloudy appearance of the water accompanied by an unmistakable odor. The oxygen content of the water is diminished and the entire equilibrium of the tank becomes upset. If this happens, immediately remove any visible sources of decay, aerate to the greatest ability of your pump, and set up an emergency filter containing glass wool or some other filtering material and activated charcoal. You can feed your organisms shrimp grown from eggs or shrimp broken into small bits.

ORGANISMS

Allow your tank to stabilize before adding specimens. Organisms can either be ordered live from a biological supply house or can be obtained in a field trip to the creeks to seine for small organisms.

NOTE: Inexpensively made equipment included in the water chapter can be used for activities on the salt marsh.

Section 1

FINDINGS: The findings of the General Assembly are enumerated. The importance of coastal resources to the present and future well-being of the state and the damage and loss of some of these resources due to population growth and economic development are emphasized. The urgent need for properly balancing economic interests with protection of resources is stated.

Section 2

STATE POLICIES: The basic state policy of protection of the coastal environment and promotion of economic and social improvement of the Coastal Zone and the people of the state as stated in Subsection A is expanded in Subsection B.

Section 3

DEFINITIONS: Important terms used throughout the bill are precisely defined--terms such as coastal zone, coastal waters, tidelands, beaches, primary ocean front sand dunes, etc.

Section 4

S. C. COASTAL COUNCIL: A council consisting of 18 members is created. (One member from each of the eight coastal counties; one member from each of the six congressional districts; two Senators and two members of the House of Representatives.)

Section 5

POWERS AND DUTIES: The powers and duties of the Council are enumerated. It is stated that the Council may delegate any of its powers and duties to the CCPS (Coastal Council Permitting Staff).

Section 6

WILDLIFE DEPARTMENT TO PROVIDE PERSONNEL: At the request of the Council, the Wildlife and Marine Resources Department will provide additional staff as well as additional conservation officers, provided funding is available.

Section 7

OTHER AGENCIES TO COOPERATE: All state and local agencies and commissions are required to cooperate with the Council in the performance of its duties, and other state agencies must administer their authority in a fashion which is consistent with this Act. The authority of the Council in the discharge of its duties is further defined.

Section 8

COUNCIL TO DEVELOP COASTAL MANAGEMENT PROGRAM: The Council is directed to develop a comprehensive coastal management program. In designing the program the Council is required to perform specific tasks in order to determine the proper levels of resource development and natural systems preservation.

Section 9

PUBLIC HEARINGS: The formal procedure for receiving public, government agency and other input into the formulation of the final management plan is outlined. The General Assembly and the Governor must approve the plan prior to final acceptance.

Section 10

PLAN TO COOPERATE WITH LOCAL GOVERNMENTS: The management program will be developed in complete cooperation with local governments including direct local government involvement in the program.

Section 11

PORTS AUTHORITY TO SUBMIT PLAN: The State Ports Authority is authorized to prepare, for Council approval, a management plan for port and harbor facilities and navigation channels.

Section 12

COUNCIL TO DEVELOP BEACH EROSION CONTROL POLICY: The Council will develop and administer a beach erosion control policy. Federal and State funds may be spent by the Council to alleviate erosion in areas to which the public has full access.

Section 13

PERMITS REQUIRED TO UTILIZE CRITICAL AREAS: A permit must be obtained from the Council before utilizing a critical area. The permitting process, the publishing of interim and final rules and regulations for evaluating permit applications, and types of construction not requiring a permit are addressed.

Section 14

SUBMISSION OF DEVELOPMENT PLANS - APPLICATIONS FOR PERMITS: Information which an applicant for a permit will have to supply the Council is specified. The section further specifies procedures for public notice and public hearings concerning an application. The Council will assist applicants in expediting permit applications.

Section 15

APPROVAL OF PERMITS: Considerations which the Council must use to determine the issuance or denial of a permit are specified. Time limits and decisions on permit applications are set and other specifics incidental to the permitting system are given.

Section 16

VIOLATIONS - JURISDICTION OF COURTS: Circuit courts have jurisdiction to restrain a violation of the Act upon suit by the Council, the Attorney General or any person adversely affected.

Section 17

PENALTIES: A violation of any provision of the Act is deemed a misdemeanor. Penalties of fines and/or imprisonment are provided

Section 18

APPEALS: The procedure for appealing the decisions of the Council is established. Unreasonable exercise of the State's police power is expressly prohibited.

Section 19

NOT TO AFFECT CERTAIN LAND: Nothing in the Act will affect titles to tidelands below mean high water mark. The State is not liable for damages caused by permitted structures.

Section 20

REGULATORY AUTHORITY OF COUNCIL RESTRICTED: The Council is prohibited from exercising direct authority over lands and waters other than critical areas. The Act does not define "direct."

Section 21

AUTHORITY OF COUNCIL: Ninety days after the effective date of the Act the Council will be the only state agency with authority to permit or deny an alteration or utilization within critical areas.

Section 22

LEGAL ACTIONS TO DETERMINE OWNERSHIP: Any person claiming an interest in tidelands may bring action against the State in order to determine legally the existence of any right, title or interest. A trial by jury will be granted upon request.

Section 23

SAVING CLAUSE: Any provisions of the Act which may be determined invalid or unconstitutional will not affect the validity of the remainder of the Act.

Section 24

TIME EFFECTIVE: The Act will take effect on July 1, 1977.

RESOURCES

As We Live and Breathe. National Geographic, Washington, 1971.

Awkerman, Gary. Aspects of Marine Ecology. SEA Title III Project, copies available from Charleston County Ocean Science Project, Dr. Gary Awkerman, Director, Charleston, South Carolina.

Barr, George. Adventures on the Beach. New York, New York: teacher's guide for grades K-12, available for \$2.50 from Board of Education of City of New York, Publications Sales Office, 110 Livingston Street, 11201. 1972.

Beakley, John C., et. al. The Source Book of Marine Science. Available from Tallahassee, Florida: Department of Education (source for reports). 1970.

Clark, John. Coastal Ecosystems, Ecological Considerations for Management of the Coastal Zone. Copies may be ordered from Washington, D. C.: Publications Department, The Conservation Foundation, 1717 Massachusetts Avenue, NW, 20036 (good for reports). 1974

Farmer, Charles H. "The Salt Marsh and Estuaries." South Carolina Wildlife. May-June 1973.

Hitchcock, Stephen W. "Fragile Nurseries of the Sea." National Geographic. June 1972.

Laurie, Pete. "Salt Marsh: A Question of Survival." South Carolina Wildlife. March-April 1975.

"Life in a Salt Marsh." National Wildlife. March-April 1977.

Salber, Lee P. Estuary: What a Crazy Place. Washington, D. C.: National Wildlife Federation, 1412 16th Street, NW, 20036. 1972.

Simon, Sidney; Leland Howe and Howard Kirschenbaum. Values Clarification: A Handbook of Practical Strategies for Teachers and Students. New York: Hart Publishing Company. 1972.

Stone, Edwin H. "Salt Water Marshes." Sandlapper. September 1971.

Taylor, Beth. The Field Approach to Coastal Ecology. Beaufort, North Carolina: Currier County Public Schools. This is an ESEA Title III Project. 1970.

Booklet: Who is Minding the Shore? A citizen's guide to U. S. Department of Commerce Coastal Management.
Washington, D. C.: National Oceanic and Atmospheric Administration, Office of Coastal Zone Management,
3300 Whitehaven Street, 20235.

Van Raalts, Charlene. "What's the Use of a Salt Marsh." The American Biology Teacher. Excellent source on
economics and uses. May 1977.

AUDIOVISUALS

The Thin Green Line, film, available from S.C. Wildlife and Marine Resources Department, P. O. Box 167, Columbia, S.C. 29202.

The Salt Marsh: A Question of Values, film, available from State Library, 08081, also from EPA, 345 Courtland Street, NE, Atlanta, Georgia 30308.

Estuary, film, available from EPA.

Series on Coastal Environments, available from Alice Linder, Environmental Education Consultant, S.C. Department of Education, in video tape form. Available for rent in slide/tape form from Instructional Services Center, University of South Carolina, Columbia, S.C. 29208. Cost of rental is \$7.50 per show.

"Dunes and Succession"

"Coastal Processes"

"Tidelands and Productivity"

"The Loggerhead versus Man: A Conflict over Resources"

"The Blue Crab"

"The Shrimp"

"The Oyster"

"The Shrimper"

"The Crabber"

The Salt Marsh, filmstrip, National Geographic, Washington.

The Salt Marsh, poster, 20" x 24", Marine Extension Center, Skidaway Island, Savannah, Georgia.

"Life in the Salt Marsh," poster, 22" x 32", supplement to S.C. Wildlife, available through S.C. Wildlife.

"Marshlands: Where the Action Is," television show, Natural Science Special, S.C. ETV.

Resource Personnel:

Office of Coastal Zone Planning

S.C. Wildlife and Marine Resources Department

Marine Resources Center

P. O. Box 12559, Charleston, S.C. 29412 (phone: 795-7341)

South Carolina Department of Health and Environmental Control

Bull Street, Columbia, S.C.

DESCRIPTIONS OF TIDAL ZONES

Source: The Field Approach to Coastal Ecology

Organisms living in the salt marsh environment must be adapted in some manner to surviving alternating periods of inundation and desiccation and the conditions which accompany the two. The zonation of the plant species in the salt marsh indicate this sort of adaptation. (See diagram p. ____.)

In the drier supratidal zone, several plants are commonly found growing in close association. The salt meadow cordgrass is generally dominant but shares the scene with sea ox-eye, spike grass, goldenrod and sea myrtle, as well as other plants and shrubs.

The salt barren represents a portion of the intertidal salt marsh flooded only twice a month during spring tides or during exceptionally high storm tides. As a result, the salinity content of the substrate is quite high and in some areas prohibits plant growth. The result is a path-like area which meanders about in the higher reaches of the "typical" salt marsh. Grasswort and spike grass grow on either side of the barren and frequently on raised areas within the barren itself. A few stunted individuals of salt marsh cordgrass will generally be found in this area.

The intertidal zone is sub-divided into the upper and lower intertidal zone. In the upper intertidal zone, as a result of poor drainage and in frequent flooding, conditions are apt to be quite salty. The salt marsh cordgrass in this area is short, 5-8 inches, and is usually found in association with the dainty sea lavender, glasswort, and the widely distributed spike grass. The lower intertidal zone is flooded with each high tide so less salt accumulates in the substrate. As a result, the salt marsh cordgrass grows tall and thick. The height of the cordgrass seems to be directly related to water availability and indirectly to elevation, drainage, iron content in the substrate and salinity. The needle rush is found in the drier areas of the intertidal zone. It may be found growing on raised mounds in the lower intertidal zone or far back into the marsh where it is reached infrequently by tidal waters. Large stands of needle rush are evident in marshes which flood only irregularly.

The subtidal zone is covered by tidal waters at all times. Various large attaching algae seaweeds are present as well as phytoplankton and zooplankton. Eel-grass, a flowering plant, grows in clumps along the bottom in the shallows. Close inspection of the eel-grass beds will frequently reveal scallops and burrowing anemones.

Any environmental factor that tends to limit the survival and distribution of an organism or a community of organisms is said to be a limiting factor. Limiting factors as they function in actual communities include: temperature, salinity, water availability, light intensity, soil type, and oxygen availability. In many cases, when one factor is altered, the organism's tolerance to other factors is also changed.

ZONATION OF PLANTS AND ANIMALS IN THE SALT MARSH

A. SUPRATIDAL ZONE

Plants

- | | |
|---|-----------------------|
| 1. <u>Juncus roemerianus</u> (infrequently) | black needlerush |
| 2. <u>Solidago sempervirens</u> | seaside goldenrod |
| 3. <u>Distichlis spicata</u> | spike grass |
| 4. <u>Spartina patens</u> | salt meadow cordgrass |
| 5. <u>Borrichia frutescens</u> | sea ox-eye |
| 6. <u>Baccharis</u> spp. | cotton bush |
| 7. <u>Iva frutescens</u> | marsh elder |
| 8. <u>Myrica cerifera</u> | wax myrtle |
| 9. <u>Ilex vomitoria</u> | yaupon |
| 10. <u>Juniperus virginiana</u> | red cedar |

Animals

- | | |
|-------------------------------|---|
| 1. Birds: | clapper rail, snowy white egret, green heron, osprey, herring gull, laughing gull, marsh hawk, least tern |
| 2. Raccoons | |
| 3. Insects | |
| 4. Rodents | |
| 5. <u>Melampus bidentatus</u> | marsh snail |

B. SALT BARREN (no plants in the most saline areas)

Plants

- | | |
|--|----------------------|
| 1. <u>Spartina alterniflora</u> (very stunted) | salt marsh cordgrass |
| 2. <u>Salicornia</u> (two species) | glasswort |
| 3. <u>Distichlis spicata</u> | spike grass |

Animals

- | | |
|-------------------------|--------------|
| 1. <u>Uca pugnax</u> | mud fiddler |
| 2. <u>Uca pugilator</u> | sand fiddler |

C. INTERTIDAL ZONE

D. UPPER INTERTIDAL ZONE

Plants

1. Spartina alterniflora (stunted)
2. Salicornia
3. Limonium carolinianum
4. Distichlis spicata
5. Juncus roemerianus

salt marsh cordgrass
glasswort
sea lavender
spike grass
black needlerush

Animals

1. Sesarma reticulatum
2. Uca pugnax
3. Uca pugilator
4. Littorina irrorata
5. Fishes

marsh crab
mud fiddler
sand fiddler
periwinkle

E. LOWER INTERTIDAL ZONE

Plants

1. S. alterniflora (tall)
2. Mud algae

salt marsh cordgrass

Animals

1. Crassostrea virginica
2. Callinectes sapidus
3. Nassarius obsoleta
4. Uca pugnax
5. Uca pugilator
6. Littorina irrorata
7. Modiolus demissus
8. Limulus polyphemus
9. Fishes
10. Marine worms

oyster
blue crab
mud snail or basket shell
mud fiddler
sand fiddler
periwinkle
ribbed mussel
horseshoe or king crab

F. SUBTIDAL ZONE

Plants

1. Zostera marina eel grass
2. Algae seaweeds
3. Plankton

Animals

1. Crassostrea virginica shrimp, oyster
2. Callinectes sapidus blue crab
3. Nassarius obsoleta (mud) mud snail or basket snail
4. Nassarius vibex (sand) mottled dog whelk
5. Fishes: mullet, menhadden, drum, croaker, flounder, shad, toadfish,
spotted sea trout, Spanish mackerel, Blue marlin
6. Marine worms

ECOSYSTEMS AND THEIR RELATIONSHIPS

Planet Earth is essentially a closed system; one cannot leave or enter. An understanding of the self-sustaining and self-regulating mechanisms in the environment assists mankind in maintaining a quality environment for all life.

Ecosystems function through chemical cycling and energy flow in order to maintain life. The fixed supply of essential elements must continuously cycle from their reservoirs through the food chains and webs of the ecosystem and back to their reservoirs. Energy is a one way flow. By studying its rate through the ecosystem, we are attempting to minimize energy waste.

The interchange of matter and energy with living things is a remarkably effective system--man has an obligation to see that it must endure.

CONTENT

In the beginning there were:
minerals, rocks and soils,
water and air supporting
plants

which converted solar
energy to chemical
food - supporting
animals
and there was
MAN

All were interrelated and
interdependent.

All were in constant change.

All used and transferred
energy.

All "were good."

An ecosystem - the abiotic
and biotic components of the
environment.

Habitat is where an organism
lives - it may be a rotting
log or an ocean.

Niche is the function of an
organism or population as
related to the total ecosystem.

Limiting factor is that one
most deficient factor in the
environment which determines
the habitat and growth of an
organism.

STUDENT OBJECTIVES

The student will be able to:

Describe the relationships
between abiotic factors and
plants and animals as they
are interrelated in a
community.

Define and describe in simple
terms: ecology niche
ecosystem habitat
community biome
population
limiting factor
biotic and abiotic

Identify on school grounds
and/or in terraria or aqua-
ria the basic components
which support or limit life.
(Ex. minerals, water, air,
space, temperature, light,
etc.)

Describe the major components
of an ecosystem.

STUDENT ACTIVITIES

Field Study:

Each group of students should
divide into three special study
groups: a. physical survey

b. plant survey

c. animal survey

Each group compiles all reports
and makes a single report to
the class. (See p. 196-200.
for suggested activities.)

Field trip through school yard.

Make a terrarium or an aquarium;
make sure all necessary com-
ponents are included.

If properly lighted, could life
continue in your aquarium in-
definitely?

A friend cleans out your aquarium
and removes all of the soil.
What will happen? What would
happen if all of the plants were
removed? In each case, what
would probably be the limiting
factor?

Select an animal in your environ-
ment and bring to class a de-
scription of its needs, ex. white
tail deer, wild turkey, bass.
What are its needs for food,
water, space, cover, etc.?

RESOURCES

Field Study:

Device to determine
wind direction,
Compass,
Thermometer,
Pencils and clip boards,
Old medicine vials or
plastic bags,
Coat hanger (white wire).

CONTENT

A community is composed of a variety of plant and animal populations interacting in a given environment.

Matter is neither created nor destroyed but is changed.

The earth is a closed system. Therefore, matter, the chemicals necessary for life must be constantly cycled and recycled.

Energy from the sun is the force used in this recycling process.

Energy is not recycled. It is a one way path, continually being lost to space. (See diagram of matter and energy cycle.)

The two major functions of any ecosystem: energy flow and matter or chemical recycling.

STUDENT OBJECTIVES

The student will be able to:

Trace the flow of chemicals through an ecosystem.

Trace the flow of energy through an ecosystem noting losses in energy along the way.

Describe their own activities in terms of location in the matter cycle and the energy flow through the system.

STUDENT ACTIVITIES

Estimate the effect of reducing any one of these essentials and explain how the factor limits the increase of the population of your selected animal.

Describe a typical limiting factor in a desert, an ocean, a city, the people in S. C.

Using a model of an ecosystem, lines and arrows, trace the flow of major chemicals through a local ecosystem. This may be a drawing or modified collage.

Using a model of an ecosystem, lines and arrows, trace the flow of energy through your local ecosystem. Note losses in energy along the way.

Using your model of an ecosystem, add as many human activities as you can and show how it affects the system. If the affect is harmful, suggest ways of reducing the damage.

RESOURCES

High school biology text

CONTENT

The most vital chemical cycles include:

Nitrogen Cycle (p.____)

Water Cycle

Carbon Dioxide - Oxygen Cycle

Phosphorus Cycle

STUDENT OBJECTIVES

The student will be able to:

Identify ways of living that would be more economic to the system in terms of recycling of matter and recapturing of energy.

Explain the major cycles and show how human activities affect each one.

STUDENT ACTIVITIES

Using any materials which you may choose, construct each cycle. Relate the essential components of each cycle to terms and information on the Ecosystem Model (p. 201-203).

Name a life function associated with each of the following sets of raw materials: CO_2 and H_2O , Nitrates and organic compounds, phosphates and organic compounds, oxygen and organic compounds.

Using a diagram of the nitrogen cycle, add the following human activities; obtain additional information concerning each and discuss the impact of each activity on the nitrogen cycle and all major components of the ecosystem:

- a. Fertilizer - nitrates and ammonium salts
- b. Erosion and runoff into waterways - ex. from cultivated fields, etc.

RESOURCES

CONTENT

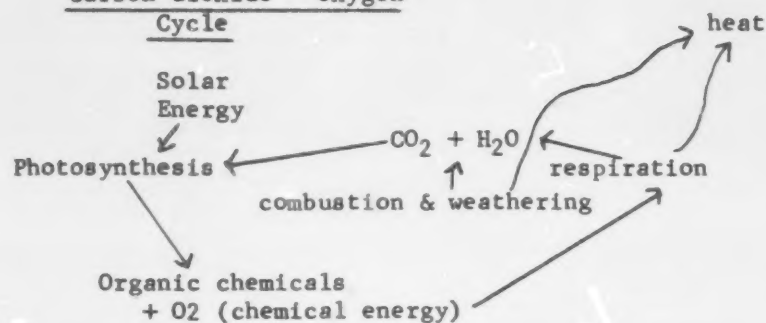
STUDENT OBJECTIVES

The student will be able:

STUDENT ACTIVITIES

RESOURCES

Carbon dioxide - Oxygen Cycle



367

- Population explosion - people and animals -- resulting in increased waste
- Industrial waste
- Cars - burning fuel which gives off nitrogen dioxide
- Others

Do the same thing with the Phosphorus cycle. Include such activities as:

- Fertilizer
- Erosion and runoff
- Detergents
- Industrial waste
- Others

Explain the possible effects of fossil fuel combustion on the ecosystem.

What effect could air conditioning have on the carbon dioxide - oxygen cycle - research and explain.

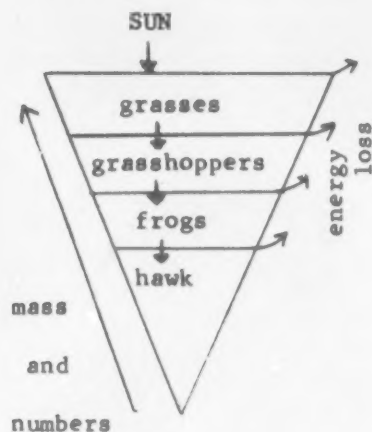
Trace the components of your car back to their sources. What effect does its production and use have on the major cycles.

189

368

CONTENT

PYRAMID OF ENERGY



STUDENT OBJECTIVES

The student will be able to:

Draw and explain an energy pyramid and show how it relates to mass and numbers.

List and describe the main components of a food chain.

Describe a food web.

STUDENT ACTIVITIES

Determine who eats whom in your environment and draw a pyramid showing the flow of energy and indicate the approximate number of individuals at each level.

From the study of your environment and your pyramid, name the major producer population.

Identify the primary and secondary consumer populations.

Discuss the statement, "For one man to gain a pound, the sea must produce half a ton of living matter."

Find in your environment a typical food chain.

Using the foods that you ate for lunch, trace them back to construct a food chain with yourself at the end.

Draw a typical food web for organisms in a local ecosystem. Identify some of the niches filled by each organisms.

Food web game.

Construct a collage illustrating a food web.

RESOURCES

CONTENT

Two laws of thermodynamics help us to understand the functioning of the ecosystem.

1. Law of conservation: energy can neither be created nor destroyed. It can be changed.
2. a. Any system or environment tends spontaneously toward increasing disorder or randomness.
- b. No transformation of energy from one form to another is 100% efficient.

Maintaining order in the form of life always increases disorder in the environment.

The increased number of humans using energy and resources, the greater the disorder in the environment. Ex. the more people the more need for food, so the more energy used for orderly farms and the more waste products dispersed into the air, water and across the land.

371

STUDENT OBJECTIVES

The student will be able to:

Cite examples of energy changes in the environment and how they are the basis of all life.

Explain entropy as the spontaneous trend toward disorder or randomness.

Give examples of entropy from daily activities.

191

STUDENT ACTIVITIES

Explain the following statement: "The shorter the food chain, the greater the available energy."

Construct a collage illustrating the first law and the statement, "There is no such thing as a free lunch."

On your way home or to school find as many examples of entropy as possible. (Ex. trimmed lawn would, left alone, become a patch of weeds.) Explain the statement and give examples "If you think things are mixed up now, just wait."

List occurrences in the everyday life that illustrate the tendency toward disorder.

Explain how the following rhyme is an example of the second energy law:

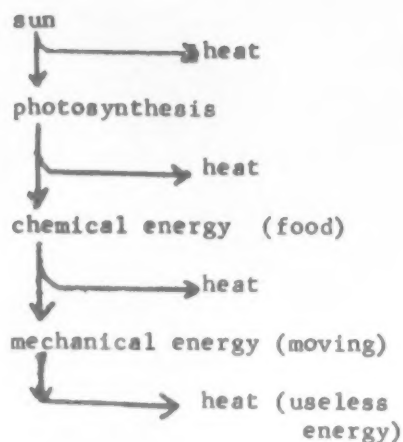
Humpty Dumpty sat on a wall,
Humpty Dumpty had a great fall,
All the King's horses
And all the King's men
Couldn't put Humpty Dumpty
together again.

Write an explanation of the statement: "The ultimate pollutant on earth is heat."

RESOURCES

372

CONTENT



A species is a population of organisms having similar characteristics and the capability of interbreeding to produce fertile young.

STUDENT OBJECTIVES

The student will be able to:

Define species and identify the major characteristics necessary for species designation.

Define population as a number of individuals of a given species living in a particular location.

STUDENT ACTIVITIES

Using the laws of thermodynamics explain why people in the undeveloped nations must exist on plants or "It won't help India to kill the sacred cows."

List all the foods that you have eaten today. Trace each back through the food chain and through the major cycles. Predict what will happen to it in your body.

Explain the statement, "We should all become vegetarians."

Compare the pyramid of numbers and energy. What is their significance in relationship to the number of people that can live in a developed country as compared to an undeveloped country?

- Choose an organism in your environment.
- Identify other organisms with some of the same characteristics. What characteristics will you look for?
- List the characteristics that the organisms have in common.
- Determine whether all organisms identified carry out basic life functions in the same way.

RESOURCES

CONTENT

Adaptation is the successful interaction of an organism with its environment. Survival of an organism depends on its ability to adapt to changes in its environment. Some organisms have been successful at adaptation to human habitation and others have not.

Certain plants will not grow in a vacant lot. The bald eagle cannot live in the city but many birds do.

375

STUDENT OBJECTIVES

The student will be able to:

Define adaptation and describe organisms that have adapted to human settlements.

193

STUDENT ACTIVITIES

- e. Obtain additional information concerning your organisms - can they interbreed and produce fertile offspring? If the organisms that you identified have similar characteristics, are many in number and can interbreed and produce fertile young they are a species.

Go outside and see how many populations of plants or animals you can find on the school ground.

Field trip to a vacant lot.

Record all observations of organisms living on the lot.

- animals - what are they doing, what do they eat?
- plants - do they provide food and cover for any animals? What is their niche?
- what adaptive characteristics enable these organisms to live here?
- if left undisturbed for 25 years, predict how this small ecosystem would look.
- would the same organisms inhabit the lot?
- draw a food web or the lot organisms showing all interdependencies.

RESOURCES

Notebooks and pencils.

376

CONTENT

Diversity is an indicator of environmental health.

Large major ecosystems are called biomes. Some familiar biomes include: grassland, desert, forest, marine and fresh water.

STUDENT OBJECTIVES

The student will be able to:

Estimate the environmental health of an area based on diversity of organisms occupying each niche.

Define a biome and describe a terrestrial and an aquatic biome.

STUDENT ACTIVITIES

- is the vacant lot suitable for human habitation?
- if you could make changes what changes would you make?

Using the Ecosystem Model, visit your school ground or a vacant lot. Determine:

- a. How many different species occupy each major niche?
- b. Estimate the environmental health of the area on the basis of diversity of organisms.
- c. What could be done to improve the quality of the environment?

Films or filmstrips showing different biomes.

RESOURCES

S. C. Audio-Visual Library Film listing.

CONTENT

Factors that can determine
biome conditions include:

climate
oxygen
carbon dioxide
water
pH
temperature
solar radiation
soil
altitude
climax vegetation
precipitation
minerals
(in aquatic biomes -
transparency
suspended materials
density
temperature
motion)

379

STUDENT OBJECTIVES

The student will be able to:

List advantages of organisms
living in a terrestrial
biome; an aquatic biome.

Explain how physical factors
influence living conditions in
at least three different
biomes.

Name three plant and three
animal species which dominate
a terrestrial and an aquatic
biome where you live.

List at least five ways by
which humans have changed the
environment in one of these
local biomes.

195

STUDENT ACTIVITIES

Divide class into small groups.
Have each group choose a biome to
study - some should study ter-
restrial biomes and some the
aquatic.

Give each group the following
list of objectives for their
study:

- a. Contrast the terrestrial and
aquatic types of biomes as to
availability of O_2 and CO_2 ;
absorption and retention of
solar heat, availability of
water and essential nutrients.
- b. Describe the physical factors
which determine and maintain
the conditions in your biome.
- c. Name the main life forms
using your biome as their
habitat.
- d. List the effects these
organisms have on the
physical environment of your
chosen biome.
- e. Describe the influence of
humans on the abiotic and
biotic components of your
chosen biome.

RESOURCES

380

A Discovery-Oriented Field Activity

Unit Objectives

- (1) to help pupils become aware of some relationships within a small area which are comparable to the macro-environment;
- (2) to provide the pupils with some tools to help them gain skills in making observations;
- (3) to provide experiences in various forms of record-keeping;
- (4) to provide some variation in the routine of hikes and "trails" which are a vital part of the core program.

Pre-Planning

Prior to the actual field experience, the students and the teacher discuss the meaning of ecology.

The equipment to be used is introduced and procedures for the field work are described. Pupils are grouped into teams and are instructed to prepare all records as a team.

Equipment

4 corner stakes - 12 x 3/8 in. dowel
12 ft. heavy string
2 to 4 small medicine vials with lids
feather vane for wind stake made from one large feather glued to a
light-weight base
one large needle
a one-inch piece of glass tubing (closed at one end)

one support made of a wooden block
2 thermometers
magnifiers
drawing paper
colored pencils
note paper
small directional compass

In addition, the teacher should also have available:

one temperature stake per two teams (six foot furring strip from lumberyard)
one wind stake per four teams (six foot furring strip with slits sawed at four levels to hold hacksaw blade
supports for wind vanes)
one gallon of distilled water
masking tape
insect nets

Procedures

1. Use the string and stakes to establish a study plot selected with care to include a variety of specimens. All the following activities are to be conducted within this area.
2. At half-hour intervals, using the temperature stakes, record the temperatures at four different altitudes within the plot. After returning to the classroom, these data will be graphed.
3. At half-hour intervals, using the wind stakes, record the wind direction at four different altitudes within the plot. After returning to the classroom, these data will be charted.
4. Sketch a map of your plot showing all significant items within the boundaries. A key should be included to identify the symbols used on the map. If weather conditions are poor, a rough sketch may be made in the field and a final drawing completed in the classroom.
5. Record a census showing evidence of animal life within the plot. This should include a count of actual individuals (if reasonable) as well as a count of varieties present. (Insect nets may be used for this.) A record should be made of any evidence of other animals which may be temporary occupants or absent (mouse runs, spider webs). Actual specimens such as the tiny jawbone of a rodent (with teeth still intact), feathers, snake and insect skins, or broken bird eggs, may be packed for further study in the classroom.
6. Record a census of plants within the plot. This should include a count of individuals as well as varieties and should indicate your evaluation of whether the plant is alive, dead, or dormant.
7. Observe the soil, noting texture (fine, coarse, sandy, or other), color, compactness (depth to which a pencil can be inserted), and pH (shake about one tablespoon of soil in a vial of distilled water, then test with Hydrion paper).
8. Use the school library to attempt to identify by names specific plants and animals. (Naming should not be as important as establishing the relationships and interdependence of living things.)

In the Field

1. Distribute equipment kits.
2. Move to the general area to be studied and select the plots (everyone make an effort to find the "most interesting plot": one containing an animal burrow, lichen-covered rocks, a particular tree, or perhaps an old stump).

3. As the investigations are being made, the teacher may circulate among teams asking guiding questions, and occasionally direct attention to specific things in a given plot. Most important, the teacher listens to the children's observations and shares their discoveries without stifling interest in further investigations by offering too much information. Pupils are encouraged to share especially interesting discoveries with other pupils.
4. At the end of the allotted time, equipment is collected, records are carefully labeled with team member's names, and all material packed for transportation back to the classroom. The study may take several days.

Follow-up

Back at school maps are completed and charts and graphs are prepared. The results are compared and the groups discuss the significance of their data. For example, when the temperature and wind direction charts are compared, questions are raised by the students that lead them to find out what causes the wind to blow. Here is an opportunity for practical library experience fulfilling a real need for information. It is also interesting to note that not all wind vanes are turned in the same direction at each observation or even in neighboring places.

SAMPLING PLANT POPULATIONS

Ecology is the study of plants and animals in relation to their environment and to each other. In addition to knowing the kinds of organisms, it is often useful to know how many organisms are in a population. If the population being studied is small, the number of individuals in the population can be determined by counting them directly. However, if the population is large--and it usually is--characteristics of the population must be determined indirectly by counting only a part of the population. The part of the population that is counted is called a sample. The number of organisms within the sample are used to estimate the size of the whole population.

You may be familiar with public opinion polls that are used to predict election outcomes and to determine TV ratings. Representatives from such polls seek the opinions of a random selection of people from widely scattered locations. The people questioned constitute the sample. Although they make up only a small portion of the population, they are thought to be representative of the population as a whole. Thus, characteristics of the sample are presumably the same as those of the overall population.

The purpose of this investigation is to become familiar with one technique which can be used to sample the population of small plants within a selected area.

How can the population of plants in a selected area be determined from the plants obtained in a sample?

test site
meter stick

wooden stakes (4)
pliers

ball of string
wire coat hanger

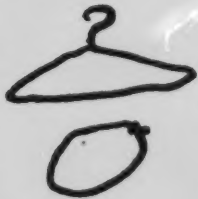
Students should work in teams of two. One team member should be the recorder, the other member should toss the sampling device. Together, both members should count the sample of plants.

1. First, prepare a sampling device. The sampling device can be made from a wire coat hanger. Using pliers, straighten the hanger by removing as many kinks and bends as possible. Then shape the wire into a loop approximately thirty--six centimeters in diameter. Fasten the ends together by bending the wire at each tip with the pliers.

2. Select a grassy plot or a vacant lot to serve as a test site. Drive stakes at each corner of an area ten meters square. Connect the four stakes with a continuous piece of string to mark the boundaries of the test site.

3. Sample the plants in the test site. To do this, close your eyes and toss the wire loop into the test site. The sample will be the plants enclosed by the wire loop.

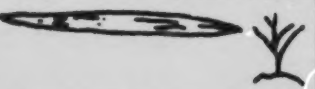
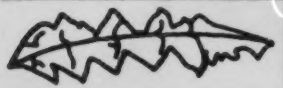
4. After making the toss, both team members should identify and count the plants inside the wire loop. If more than half a plant is within the wire loop, count the plant. If less than half a plant is within the loop, do not count it. Record the kinds and number of plants in the table under OBSERVATIONS, DATA, AND ANALYSIS. If you are unable to identify a type of plant in the sample, sketch a leaf of the plant in the column labeled Kind of Plant. Then count and record the number of plants representing that picture.



5. Standing at the place where the wire loop first landed, repeat the toss. Close your eyes and toss the loop into another area of the test site. After identifying and counting the number of plants within the loop, record your data in the table. Repeat the procedure until the plants from ten samples have been identified and counted, and the data are recorded in the table.
6. Determine the percentage of the total population that was represented by each species (kind of plant).

As you count the number of plants, record the data promptly in the following table. Use the data to answer the questions.

NUMBERS AND PERCENTAGES OF PLANTS

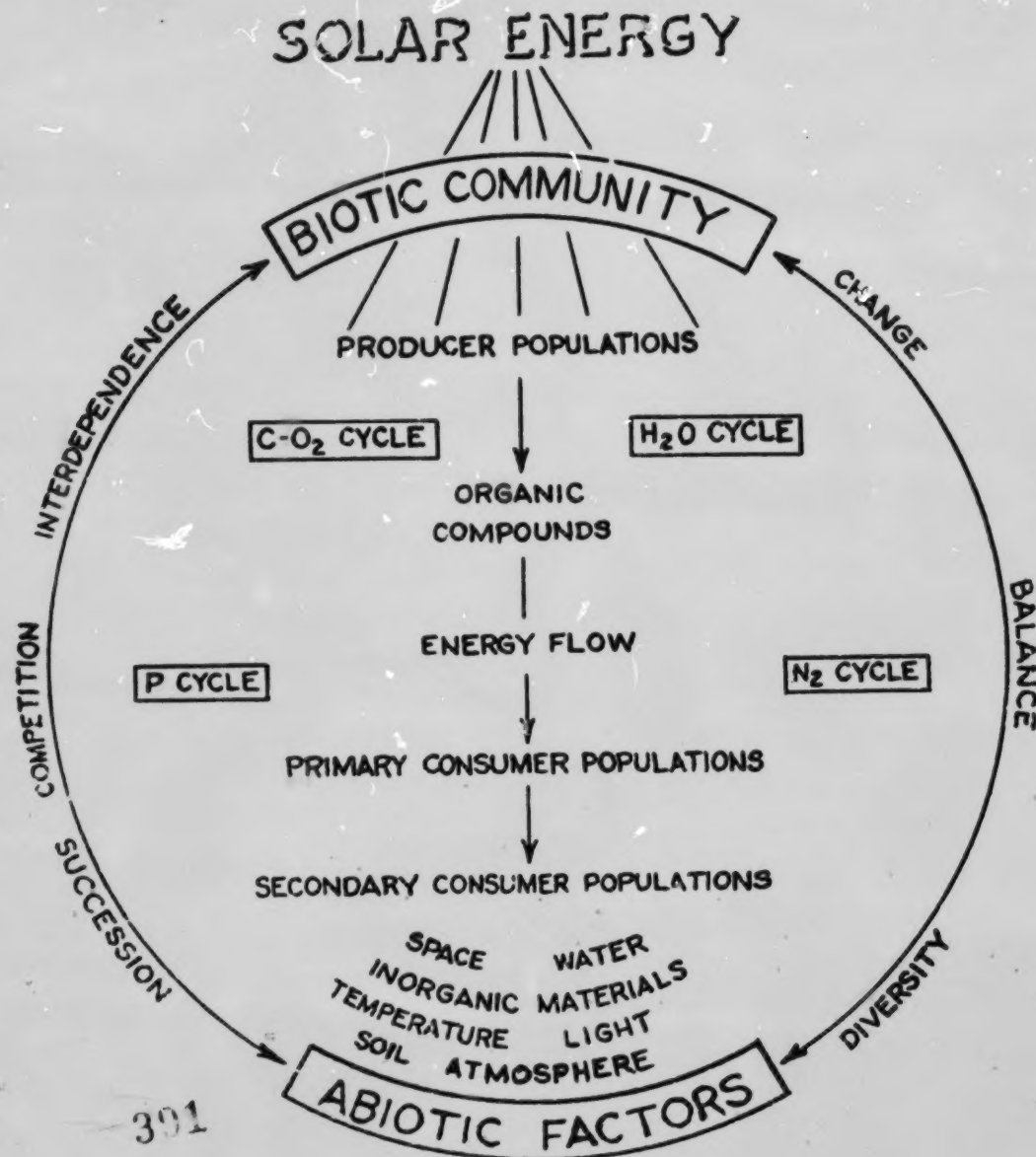
Kind of Plant	Number of Plants in Each Sample										Total Number	Percentage of Total
												
												
												

1. What was the total number of plants in all the samples?
2. What kind of plant had the largest number?
3. What percentage of the total population of plants was represented by the kind of plants having the largest number?
4. What kind of plant had the smallest number? What percentage of the total population was represented by the kind of plant having the smallest number?
5. The general distribution is indicated by the number of samples which contain that particular plant. According to your data, what plant appeared in most samples? Was the kind of plant that appeared in most samples the same as the kind of plant having the greatest total number? Explain your answer.

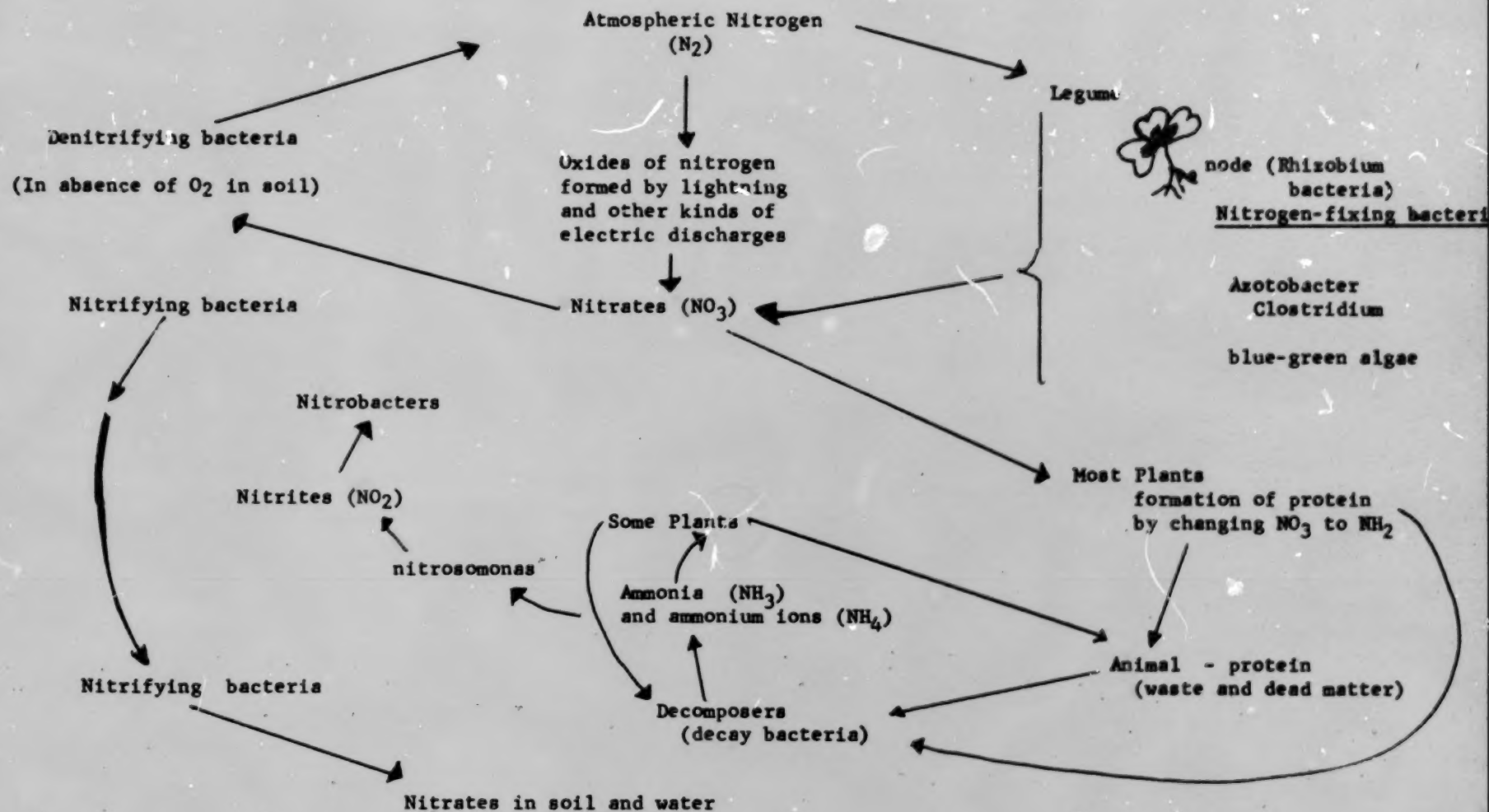
Based upon the information in the diagram, answer the following questions.

1. What is the ultimate source of energy for the survival and maintenance of all life in the ecosystem?
2. Name the two major interacting components which comprise every ecosystem.
3. Identify the physical factors which are essential to the survival of living things.
4. Name in proper sequence those categories of organisms which channel the sun's energy through the ecosystem. What is this commonly called?
5. Describe the function of decomposer populations in the ecosystem. How do they contribute to energy flow of a food chain?

Adapted from An Environmental Syllabus, New York State Department of Education

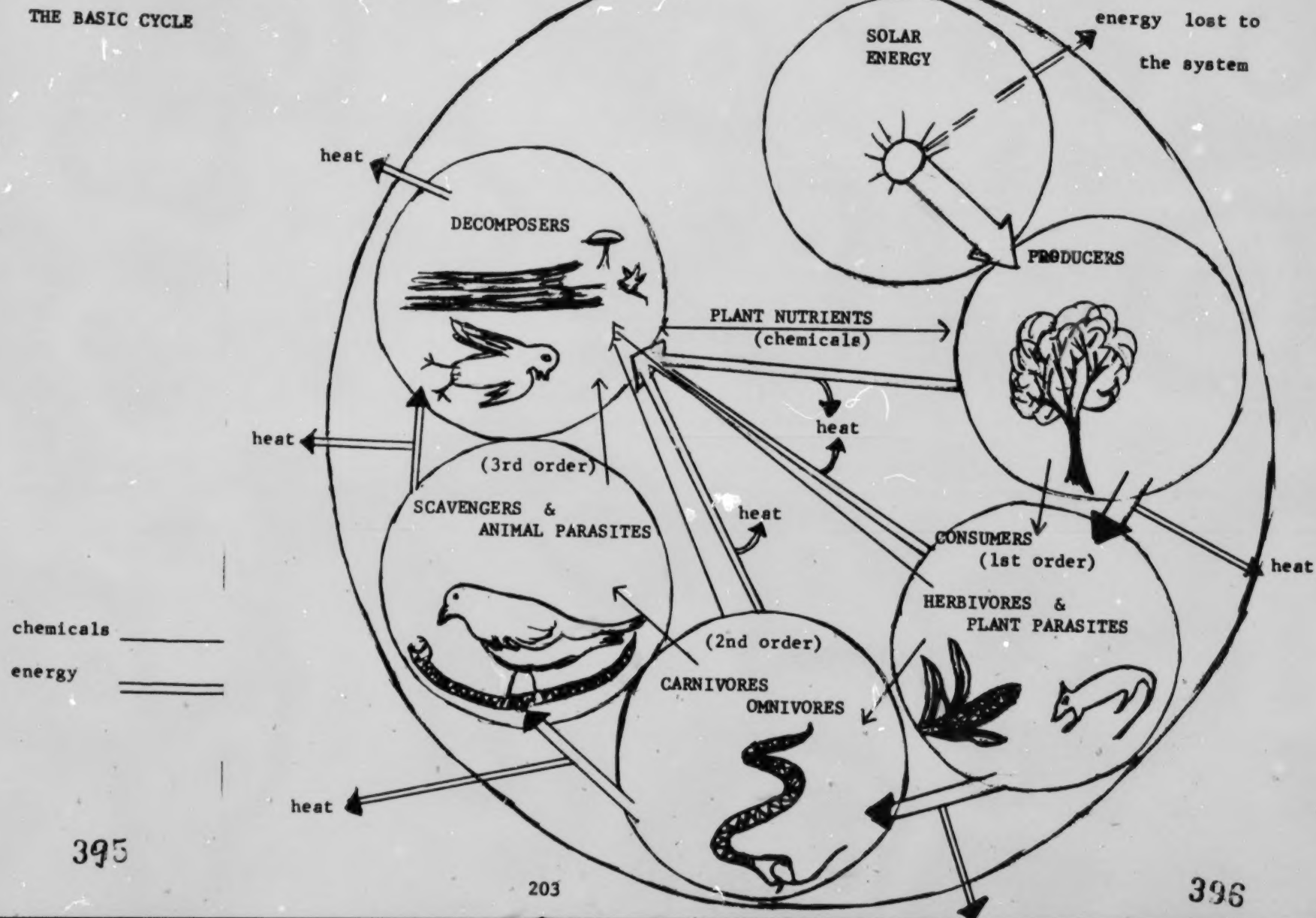


NITROGEN CYCLE



MATTER AND ENERGY

THE BASIC CYCLE



LAND USE AND YOU

Land, the provider of life's necessities, was thought to be a limitless resource when our state was settled. Since that time, this vital resource has been altered by mining, cutting of forests, by poor agricultural practices, increased miles of highways, acres of housing developments, shopping centers, parking lots, and industrial complexes. As we have lost contact with the land, we have also lost respect for the land, and our increased demands for recreational resources, food and fiber have placed added stress on this priceless resource. Due to legislation and the work of regulatory agencies, as much land is now being reclaimed as is being disturbed. Because of global interdependence, misuse of land can have long-range impact affecting many other parts of the world. Many South Carolinians are aware of conservation practices and today, efforts are being made to correct the mistakes of the past.

Land use is not a new concept. There are already more land-use programs than the public realizes. There are many laws and policies that determine land use. For example, the morning news announces that your water will be cut off for eight hours for the installation of a new pipe. Can you direct the placement of that pipe? Can your city council? County government, State Water Resources Commission? In many instances, water pipes and sewer pipes must be placed according to federal law.

If your town wanted to build a sewage treatment plant, you would have to obtain a national pollutant discharge elimination system permit. You might need as many as six permits from the Department of Commerce, Building Codes Division. Then there are more permits to be obtained from state agencies.

There is already much federal and state legislation regulating land use. One of our major land-use programs is directed by the highway department which is responsible for the statewide transportation system. The state is also responsible for recreation needs and has an extensive planning program for land acquisition and use across the state. This is directed by the Department of Parks, Recreation and Tourism. The Department of Health and Environmental Control also has statewide concerns related to land use planning. The State Development Board in its concern for economic growth and the attraction of industry plays a key role in land use planning.

The more recent Tidelands Bill is an example of legislation relating to land use planning at the state level, and the Heritage Trust program is an additional state project showing concern for our valuable South Carolina resources, and making an effort to provide wise management and conservation of our priceless heritage.

Although federal and state governments have set some guidelines and standards for land use planning and management, the greatest need today is for better planning and management by individuals and local government. Well-informed citizens are needed to provide a positive influence in the development of local plans within the parameters of state and federal control. Such citizen participation paves the way for compromise between state and local governments. It provides the state with a picture of citizens' reactions to issues under discussion. Traditionally, government officials hear from their constituents only on election day. However, through individual participation in public affairs, state government can have an "early warning system" which provides for a more responsive government.

Citizen participation has a drawback. It often brings with it increased expense. More frequently than not, those participating are against a project. Persons with favorable responses are not heard. Often citizens participate because of emotional involvement rather than as a result of careful analysis of comprehensive information. As a result projects are delayed thus adding thousands of dollars to the projects' costs. It is the individual citizen who pays for this delay through higher taxes.

If the public knew how much these delays cost, they might be more willing to play an active and more positive role in the process. With adequate education and information, citizen expectations can be more realistic, and thus whole groups of the public will not become alienated when they lose a decision.

Planning is not a one shot thing. It is continual, and it needs informed public participation on a continuing basis. High school students and future community leaders need to understand:

what land use programs and legislation is already affecting land use,
the importance of public participation in land use decisions,
the dangers of misuse of citizen participation.

CONTENT

Determination of land use.

Land use is determined by many factors, soil, altitude, topography, general weather conditions, etc.

S. C. has distinct regions and economies related to topography and other physical land characteristics.

STUDENT OBJECTIVES

The student will be able to:
Recognize the differences in geographical location of land use.

Describe the correlation between population and land

Relate geographic characteristics to reasons of early settlement by people.

STUDENT ACTIVITIES

Obtain information from reference library on percentages of total acreage used for forests, cropland, grazing, recreational purposes, cities, etc. for S.C. and other selected states.

Obtain data on population of S.C. per acre of land for the state and the U.S. Show this data as percentages in graph form.

Indicate cultural, social and economic factors which cause differences in land use practices in different states.

Based on data of population trends, predict future changes in the way land will be used.

List geographical factors which influenced the location of early American settlements in S.C., and the lifestyles and occupations. Give specific regions and areas where development reflects these factors.

RESOURCES

Atlas, encyclopedia, geography textbooks, etc.

Courier of Agriculture, U.S. Department of Agriculture, Washington, DC

S.C. Land Resources Conservation Commission

Film: Carolina Heritage, 27 min. S.C. Wildlife Dept., Columbia, S.C.

The Palmetto State. A handbook on S.C., State Department of Education, Columbia, S.C.

CONTENT

Major changes have occurred in land use since the formation of this country

Soil investigation

403

STUDENT OBJECTIVES

The student will be able to:

Illustrate how time changes land use.

Observe soil erosion and soil structure.

208

STUDENT ACTIVITIES

Identify and list geographical factors that influence the location of industries, tourist attractions, cities in South Carolina.

Research land use in colonial S.C. Make a map showing colonial land use. Make a map showing current land use. Compare the two.

Select a speaker, if available, to discuss historical growth of your community.

Make a display of maps and pictures (old and new) in your area.

Class preparation for field activity. Divide class into groups. Describe various samples of soil (use baby food jars with samples for each person) as to color, texture, odor, moisture content. (The samples should include sand, silt, and clay.) Push and rub moistened sample between thumb and forefinger. Determine if gritty, smooth, slick, or

RESOURCES

Geography and World Affairs

Social studies textbooks

Slide Set: S.C. Growing: Ready or Not. Environment Consultant, S.C. Department of Education, Columbia, S.C.

Slide program: The New Life U.S. Soil Conservation Service

Book, A Guide to Terrestrial Ecology. William A. Andrews, Prentice-Hall, Inc., Englewood Cliffs, N.J.

Paperback book, Man and Environment, Vol. 2. McCabe, Robert H. and R. F. Mines, Prentice-Hall, Inc., Englewood Cliffs, N.J.

404

CONTENT

STUDENT OBJECTIVES

The student will be able to:

Show how erosion has changed land use.

Observe water movements through soil.

405

209

STUDENT ACTIVITIES

plastic and label.
Gritty - sand; smooth and slick, not too sticky - silt; smooth, plastic, very sticky - clay.

Conduct an erosion survey on campus.
Make a drawing and mark with 3 colors: green - no erosion; yellow - slight erosion; red - severe erosion.
Discuss kinds and causes.

Observe and list examples of land use change due to erosion. (Example: eroded land has been planted with trees.)

Give each group of students a quart can with both ends removed. Each team, having picked a dissimilar site, presses their cans one inch into the soil. Pour one measured quart of water into the can and record the amount of time it takes the water to completely seep into the soil. Compare results. Discuss.

RESOURCES

Slide sets: Streams, Flooding and Flood Plains.
Analytical assessment of the types of streams and stream channels.

Slide sets: Ways to Decrease Flood Damages. 12 min.,
S. C. Land Resources Commission.

406

CONTENT

STUDENT OBJECTIVES

The student will be able to:

Recognize soil differences
by observation and testing.

STUDENT ACTIVITIES

Field Activity:

Select a forest area and ask each student to give in his/her own words a description of the soil. (Save this description for further reference.)

Divide the class in groups of 3 or 4, allow 15 minutes in which they observe the area and predict what things they will find in the top few inches of the forest floor.

Stake out a 2 or 3 foot square and sift through top 3 inches, recording evidence of plants and animals.

Information should include name or description of item, quantity, and possible effect on soil. Identify organic layer at top of soil as:
(1) litter (identifiable dead things on surface);
(2) duff (partially decomposed organic matter - compacted);
(3) humus (almost completely decomposed, nonidentifiable organic matter). For each of the above, describe the feel and identify parts of plants and animals

RESOURCES

Reference lab: A Lesson Plan for Some Investigations for Land Use Planning. July 1973, Commission of Forestry, 5500 Broad River Road, P. O. Box 287, Columbia, SC 29202

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

found. Move the group to a soil profile or soil pit. Demonstrate how to use ph kit in front of entire group. Explain ph range for plant growth. Observe the profile and general appearance, texture, temperature, and ph (record the color changes). Students will carefully place samples of each layer of soil in order in a baby food jar. (Explain that this is a micromonolith.)

Return to lab. Issue information on soil conditions as related to color.

RESOURCES

Ph kit, Hach Kit (Can be borrowed from U.S. Forest service at their Columbia office). Hach Chemical Co., Box 907, Ames, Iowa 50010.

Top Soil	dark	moderately dark	light
Amount of organic material	most	moderate	low
Erosion factor	low	medium	high
Aeration	excellent	good	low
Available nitrogen	excellent	good	low
Fertility	excellent	good	low

CONTENT

STUDENT OBJECTIVES

STUDENT ACTIVITIES

RESOURCES

The student will be able to:

Subsoil

dull gray - water logged, poor aeration

yellow, red-brown, black - well-drained soil

mottled gray - somewhat poorly to poorly drained soils

Land Use & Misuse

Describe the importance of proper land use.

Using the data collected, write an explanation: I feel the best uses of this land would be... (Justify your answers using your data).
Compare data with original description of soil.

Collect information on planned cities such as Reston, Va.; Brasilia, Brazil; or Columbia, Maryland. Compare to an unplanned metropolis. What are the advantages and disadvantages of both planned and unplanned urban areas.

Interview county agent concerning proper conservation practices.

Select speakers to present zoning characteristics and explain specific codes, to discuss how industry, business, housing, and recreation expands, and to discuss at what expense this expansion occurs.

Film: Urban Sprawl vs. Planned Growth. (Illustrates the importance of conservation planning in connection with urban development - 25 min). S.C. Land Resources Commission, Columbia, S.C.

Recognize local zoning laws and their use.

CONTENT

Land Planning

413

STUDENT OBJECTIVES

The student will be able to:

Describe some of the conflicts that exist in land management.

The student will interpret data from simple base maps.

213

STUDENT ACTIVITIES

As a summary, produce a mock brochure describing your community to prospective citizens.

Student will play the Indian Valley Game.

Assign reports or invite speakers on various objectives of land use management. Preservation organizations may be included (Sierra Club, National Audubon, etc.).

Participate in simulation game.

What are the apparent advantages and disadvantages of both planned and unplanned urban areas? In which area would you choose to live and why?

The accompanying map, p.231 represents a rural area given to the town of Freeman, S.C. by a family who had owned the land for generations. Several specific conditions were in agreement.

RESOURCES

Indian Valley Game p. 219-228.

Regional Council of Government Planning personnel

Local Area Game p. 229.

414

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

- A. No more than 20% of land might be sold for single family residences.
- B. No more than 20% of land might be sold for commercial establishments.
- C. No more than 10% to be sold for apartments and condominiums (no more than 8 units each).
- D. No more than 15% for commercial recreational areas.

The former owner directed that a board of 9 members serve as advisory committee for developing and implementing plans.

The class may serve as a mock advisory committee, after each member has answered the following questions.

- A. How many square miles in area? (kilometers)
- B. How many acres?
- C. What is contour interval?
- D. Where is the area level?
- E. Where is there a steep slope? A gentle slope?

RESOURCES

CONTENT

STUDENT OBJECTIVES

The student will be able to:

Depict examples of
land use with plot plans
and area maps.

417

215

STUDENT ACTIVITIES

- F. What is the elevation of the highest point? The lowest point?
- G. Where is there a swamp? A hilltop? A depression?
- H. How do contour lines indicate streamflow?
- I. How are directions indicated?
- J. What is the gradient of each of the streams?

Groups of students are asked to develop ordinances which will promote the best land use and abide by the agreement. Each group will develop proposed maps and transparencies of their recommendations. Present to class and discuss by class. Discuss personal property rights.

Students work in pairs and use map. Write answers to questions. Which region has probably been altered least by human activities? Explain. What effect would an additional industrial park have upon the environment? Would you support legislation to rezone any of this area for a second

RESOURCES

Page 232.

418

CONTENT

STUDENT OBJECTIVES

The student will be able to:

Practice decision making concerning land use planning.

STUDENT ACTIVITIES

industrial park?
Give advantages and disadvantages. Using the areas, forest preserve, suburbia, city and farmland, arrange them in order from the most to the least surface water runoff from a moderate rain. Write the feasibility of building a shopping area and housing development in the forest preserve, and in farmland. Does the map represent a well-planned area? Explain. Have a class discussion when answers are completed.

Case Studies p. 233.

If you lived in a location that was judged extremely desirable by significant numbers of people, many of whom were potential migrants to your locality, would you wish to be able to decide how many people should share your contentment? Explain, citing a real or hypothetical locality, its attractions, and your reasons for either sharing or maintaining exclusivity.

RESOURCES

REFERENCES

Dickey, Gary and Carol Speight. "Going Home," South Carolina Wildlife, volume 24, no. 2, March-April 1977.

Kohl Saat, Tom. "Which Way Carolina?", South Carolina Wildlife, volume 22, no. 6, Nov.-Dec. 1975.

Land Resources Today - Issues - Citizens Roles - Policy Instruments. Extension Service, U. S. Department of Agriculture, Washington, DC. 1975.

Land Use Planning in South Carolina: An Overview. South Carolina Land Resources Conservation Commission. (Covers constitutional federal, state, and county planning programs.)

Mining and Reclamation in South Carolina. South Carolina Land Resources.

"One-third of the United States is Up for Grabs," National Wildlife, Dec.-Jan. 1971.

South Carolina State Land Use Planning and Management Study. Wilbur Smith and Associates, 1973.

Speight, Carol. "Our Land: Changes and Challenge," South Carolina Wildlife, volume 20, no. 1, Jan.-Feb. 1973.

Ph AND PLANT GROWTH

1	4.5	6.5	7	8.5	14
(1 to 4.5 is too acid for most plants)		(Most plants do best here)		(8.5 to 14 is too alkaline for most plants)	

Example of plants in ph range:

- ph 4.0 - 5.0: rhododendrons, camellias, azaleas, blueberries, fern, spruce
- ph 5.0 - 6.0: pines, firs, holly, daphne, spruce, oaks, birch, willow, rhododendrons
- ph 6.0 - 7.0: maple, mountain ash, pansy, asters, peaches, carrots, lettuce, pines, firs
- ph 7.0 - 8.0: beech, mock orange, asparagus, sagebrush

THE INDIAN VALLEY GAME

Developed By: Norman C. Thomas in cooperation with the American Forest Institute.

Students will divide into six teams. Five will represent a different interest in forest land use, and one will represent a multiple-use committee charged with merging all uses of the valley into one plan.

Each team will analyze the valley and draw up a plan for achieving the highest possible yield of long-term values.

Each team will select three projects and make a presentation in support of each project before the multiple-use committee.

To prepare its master play for the valley, the multiple-use committee may select a total of 10 projects from among the 15 projects the five teams will request. The committee will choose the 10 projects on the basis of which teams made the clearest presentation, answered questions best and proposed projects that also benefit other forest uses represented by other teams.

THE GAME KIT

The game kit contains the following items:

1. A master sheet showing "Indian Valley." (Reproduce copies for each student and one transparency for use on the overhead projector.)
2. A master sheet for each of the resource teams. Make copies for each member of the group.
3. A master sheet listing instructions for the multiple-use committee, and worksheet for scoring. Make copies for each member of the multiple-use committee.

HOW TO BEGIN THE SCENARIO

To create a climate of involvement, it may be desirable to build a story around a town of Indian Valley prior to beginning the game.

An approach may begin with discussion of the rising demands for water, recreation, and timber for shelter, paper, etc., as U. S. population grows.

PLAYING THE GAME

Divide the class into six teams to represent;

1. Water resources
2. Parks and recreation resources
3. Timber resources
4. Fish and game resources
5. Fire protection
6. Multiple-use committee

Instructions for each group are on their respective worksheets. Go over the objectives of each group so its members have a clear idea of their goals.

Each group should now examine its objectives and prepare a plan for presentation to the multiple-use committee. Each group will present its case to the multiple-use committee in turn. At the end of the presentations, the multiple-use committee will total the points earned by each group and award the projects.

The multiple-use committee will award 10 points to a resource team for each of its projects which is approved. making a total of 30 points possible. However, a resource team may still earn two points for one of its projects

which was denied is proposed and approved for a previous team.

During the planning period, teams should cross-check to learn which groups will propose the same project. When two or more teams intend to propose the same project, they should confer and compromise with each other in order to agree on details of development, or location of that project. Where to cut timber, for example, or where a road should go would be matters for negotiation. The overhead projector lends itself admirably to this phase of the game, since various plans of different teams can be reproduced on transparencies and compared on the screen as overlays.

The game is open-ended. There is no single "correct" prescription for management of a given area of forest land.

POST-GAME ACTIVITY

Hold a general class discussion at the end of the game to consider such questions as:

1. Was the best combination of projects selected?
2. To what extent was it possible to make one use of land supplement or support another use?
3. What would be priority items for the next session of the game if play were to continue from this point?
4. Were there any unanswered questions that came up during the game which deserve further study and report?

MASTER SHEET - MULTIPLE-USE COMMITTEE

As a member of the multiple-use committee, it will be your job to evaluate the presentations given by each group, make decisions as to which projects will be accepted and which will not.

Only 10 of the 15 projects may be selected. While the other teams are planning their presentations for your committee, you should "float" among them to become familiar with their problems and to evaluate the research and preparation in which they are engaged.

After each presentation to your committee, score the group in each of the categories on the worksheet (see example below). At the end of the game, total the scores for each group and award the 10 highest-ranking projects your approval.

If two groups propose the same projects, you may grant approval to both groups, counting each approval separately toward the total of 10 approved projects.

Example of how to score the master plan worksheet:

Group making presentation Parks and Recreation

Project requested Road System

	Poor				Excellent	
Was their presentation clear and well prepared?	1	2	③	4	5	
Did they answer questions well?	1	②	3	4	5	
Does the project benefit other forest uses?	1	2	3	④	5	
During planning, was their research thorough?	1	2	③	4	5	TOTAL <u>12</u>

MASTER PLAN WORKSHEET

Group making presentation _____

Project requested _____

	<u>Poor</u>				<u>Excellent</u>	
Was their presentation clear and well prepared?	1	2	3	4	5	
Did they answer questions well?	1	2	3	4	5	
Does the project benefit other forest uses?	1	2	3	4	5	
During planning, was their research thorough?	1	2	3	4	5	TOTAL _____

MASTER PLAN WORKSHEET

Group making presentation _____

Project requested _____

	<u>Poor</u>				<u>Excellent</u>	
Was their presentation clear and well prepared?	1	2	3	4	5	
Did they answer questions well?	1	2	3	4	5	
Does the project benefit other forest uses?	1	2	3	4	5	
During planning, was their research thorough?	1	2	3	4	5	TOTAL _____

MASTER SHEET PARKS AND RECREATION RESOURCES TEAM

To Increase Recreation Values

1. Recreationists are drawn to lakes and streams. Build a campground and picnic areas at strategic points where water is available and where people can fish. One campground, two picnic areas count as a single project.
2. Recreationists need roads for access. Build a system of roads so families can spread out and find opportunities for picnicking, camping, etc.
3. Keep some areas in a wilderness state (no roads or other improvements) for the hiker who seeks solitude. Areas usually selected for wilderness consist of high mountain country with superlative views. Setting aside one roadless wilderness counts as one project.
4. Be alert to special opportunities for serving rockhounds, amateur archaeologists, etc. Preserve small areas of unusual historical or botanical interest. Designation of two such special use areas counts as one project.
5. Practice landscape foreground management around lakes, along rivers and roads by removing scattered dead, dying, or diseased trees to improve esthetic appearance and create open, parklike atmosphere. Remove trees where they wall off a panoramic view. Landscaping one lake, one river, or one road counts as a single project.
6. Some people like to hike or ride horses. Build trails for this use. Three trails count as one project.
7. Winter recreation should be considered. Develop a ski area on a mountain slope accessible by road.

MASTER SHEET WATER RESOURCES TEAM

To Increase Watershed Values

1. Designate or create a reservoir for municipal water supply.
2. Restrict public access to watershed area to insure purity of water.
3. Make small openings in the forest through harvesting. This lets more precipitation reach the ground while surrounding trees prevent fast runoff. It also reduces transpiration of water by trees. Five logging operations count as one project.
4. Build fire lookout towers. If large areas of forest are suddenly denuded, runoff takes place too quickly.
5. Replant watershed where it is denuded of vegetation. Replanting or seeding one area counts as one project.
6. Thinning dense young stands is another means of increasing water flow while maintaining soil stability and water quality. Two thinning operations count as one project.

MASTER SHEET TIMBER RESOURCES TEAM

To Increase Timber Growth and Utilization

1. Arrange for harvest of mature and overmature stands of trees. Their net growth has stopped and they are susceptible to attack by fire, insects, and disease. Five small logging operations are authorized for one project.
2. In stands of trees not suited for full harvest, salvage sick, dead, or fire-killed trees that are still useful. Two salvage operations constitute one project.
3. Thin out younger stands of trees, taking the poorest to make room so the better trees can put on more

growth. Thinning operations are authorized in two areas as one project.

4. Build a road system that gives access to all areas where trees are being grown for harvest. This makes it possible to take out even single trees that are blown down by windstorms or killed by insects or disease. Scattered dead and dying trees are found throughout all stands of old timber.

5. Most openings in the forest rescued themselves naturally from surrounding trees. But problem areas where the seed source has been destroyed, or quick regrowth is desired, need planting or seeding. Select one area for either seeding or planting per project.

MASTER SHEET FISH AND GAME RESOURCES TEAM

To Increase Wildlife Values

1. Make many small openings in the forest by harvesting trees. This lets sunlight reach the ground and cause food plants to grow. Game finds both food and hiding at these edges. Five harvesting operations count as one project.

2. Plan a road system that will spread hunters and fishermen evenly. This makes possible controlled harvest of game.

3. Pull windblown and other dead trees out of creeks to permit fish passage upstream. Clearing one creek for its entire length counts as one project.

4. Thin dense young timber on water shed to insure streamflow during dry season. This will help fish, and also enhance browse for deer and elk. Two thinning operations count as one project.

5. Protect the habitat of rare species that cannot live with man. Give them sanctuary for nesting and

refuge from hunting. One sanctuary and one refuge count as one project.

6. Locate muddy spots that mean potential springs. Opening five springs counts as one project.

MASTER SHEET FIRE PROTECTION TEAM

To Assure Fire Protection

1. Build a road network that will enable firefighters to reach any area that might catch fire.
2. Build lookout towers that will give a view of the entire area. Three towers constitute one project.
3. Fell dead trees, especially on ridges. They become flaming torches if struck by lightning. Two operations count as one project.
4. Create impoundments around natural springs accessible by road at strategic locations so that firefighters can refill tanker trucks quickly when fighting nearby fires. Five spring impoundments count as one project.
5. Aerial patrol of forests for early detection of fires and control of firefighting operations from the air is an important aid. Build an airstrip for aerial operations in an open meadow location.
6. Old, mature timber contains a high percentage of dead trees, making it susceptible to fire. Begin harvesting these areas so young trees can take over. Five small logging operations count as one project.

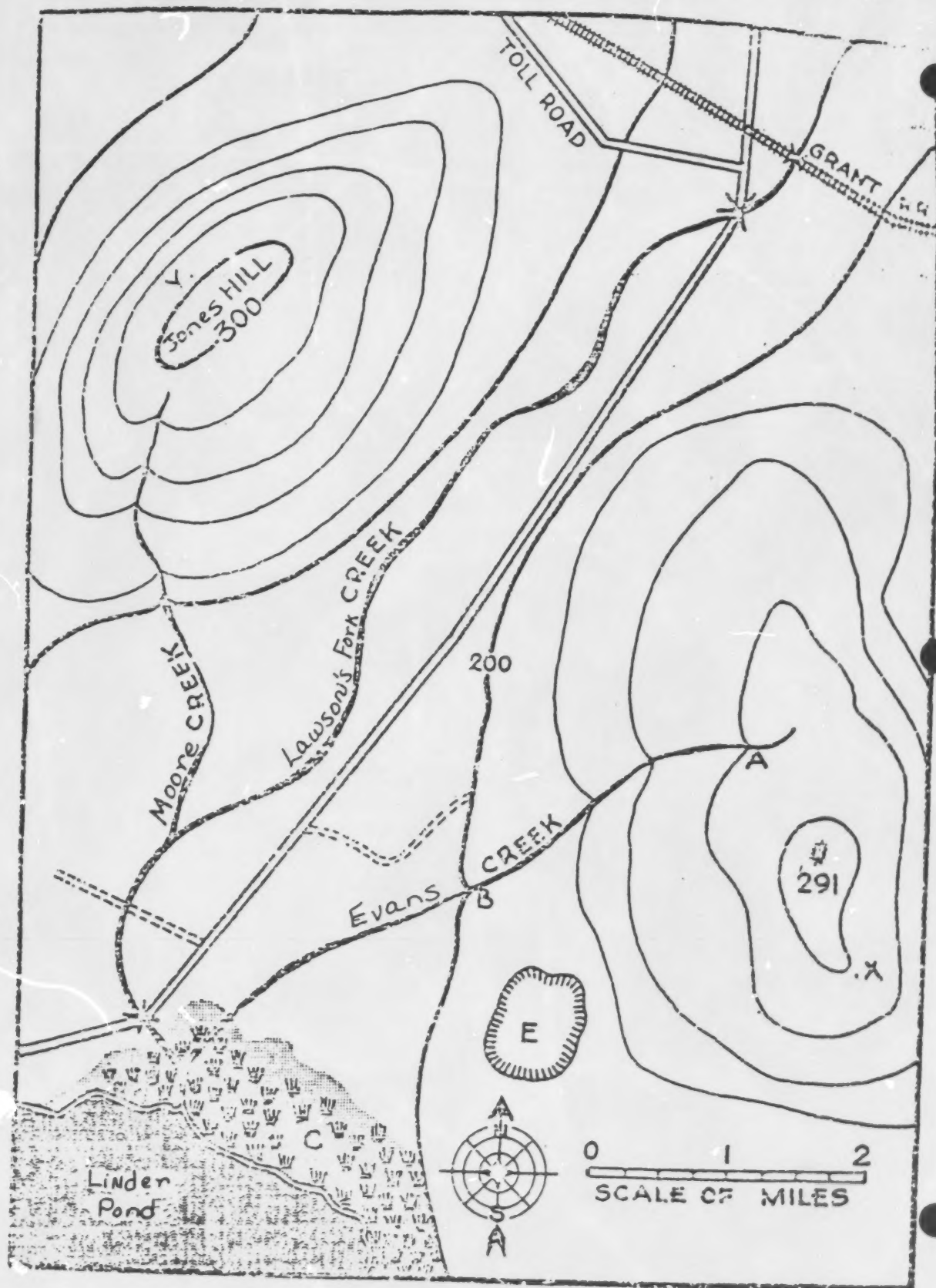


LOCAL AREA SIMULATION GAME

Select an area in your community such as a park or any similar spot that students know and in which they have an interest (urban or city, please). Develop several logical proposals for "better" uses of the land. Divide the class members into groups to represent each proposed land use, and to represent environmentalist, concerned citizens, and jury. Drawing lots for the group is a suggested method. Have each group investigate thoroughly their interest. A spokesperson for each group should be elected. Concerned citizens should take turns sitting in the meetings of each group as well as interviewing some of the real citizens of the area (explain the game, ask what their feelings would be if these were real issues). The jury should investigate the environmental legislation of the state, county, and municipality by contacting the proper agencies and obtain as much information as they can about the land in question and the community. The teacher should meet with each group guiding them with questions. Field trips to the area in question are necessary for all groups to obtain some information (plant and animals present, accessibility, etc.). After an allotted time, each group is allowed to present their case to the jury. An elected judge (who may be the teacher) will maintain order during the proceedings. Each group is given an opportunity to cross examine each other group after their presentation through their spokesperson. Each group also has a final chance to briefly state their case at the conclusion of the "trial." The jury is allowed to make a decision but must justify it to the rest of the class. As a final activity the class is allowed to decide if the jury made the decision which they personally feel might be best for the community.

EXAMPLE OF SIMULATION

Guignard Park in Cayce, South Carolina was selected as the area in question. It is a delightful park which serves as a refuge for many of all ages from the streets, shopping centers, parking lots of the area. Parkland Shopping Center is immediately across the street and "needs to expand and has no other recourse." They believe that this could be the best possible use of the land. The City Council "believes that this park is just the spot for a second fire station since the fire station is located in the outskirts of Cayce and is not in a central location." Brookland-Cayce Trustees "believe that this park is the ideal place to expand the local high school since there is no other space to build in order to accommodate the growing student body." The high school is within a block of this area. The Council on Aging "believes that the park should be developed in a way to be used by senior citizens. A building should be built to accommodate activities for this group." Lots were drawn for group assignment and even though some students were not pleased with their assignments, they felt that this was a fair method to divide into groups. Field trips were made to the park during class periods. Students worked together to prepare their cases. Cases were presented and a decision made with which all of the students agreed. The students expressed the feeling that this had been a most beneficial experience which made them become much more aware of the idea of proper land use for the good of the most people. Incidentally, their decision was to leave the park as a park but to build buildings in it which could serve to be a meeting place for the elderly and to establish a petting zoo for the children.



UTOPIA
S.C.

FARMLAND

FOREST

FOREST

STATE PARK

SANITARY
LANDFILL

CITY

SUBURBIA

WATER
FILTRATION
PLANT

INDUSTRIAL PARK

SEWAGE
TREATMENT
PLANT

Direction of water flow

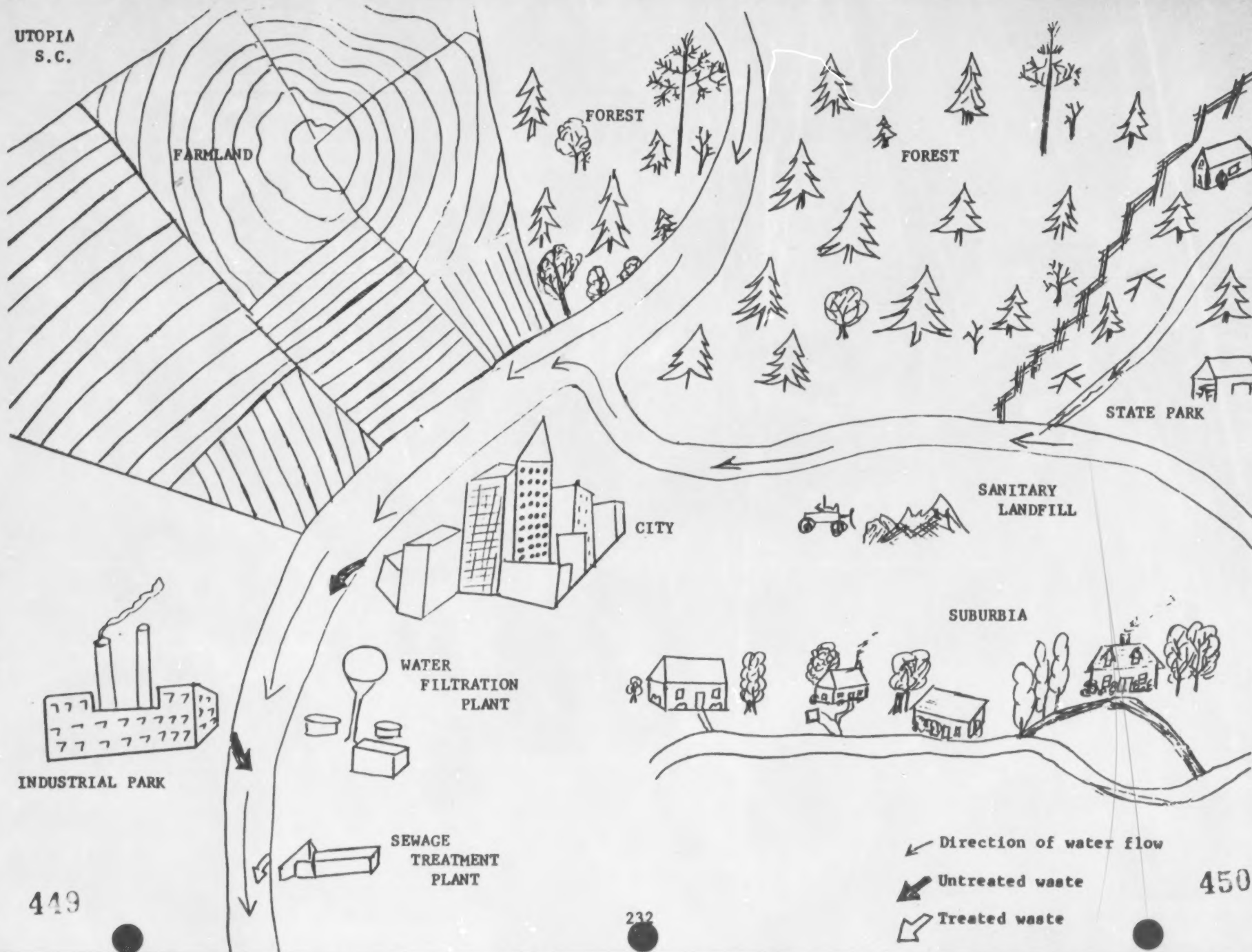
Untreated waste

Treated waste

449

232

450



CASE STUDY: Consider the following information and prepare your input as plans are made to make the Congaree flood plane a National Park

(case studies from the 23rd National Conference of the Conservation Education Association)

The 19 national forests have been subdivided into 97 planning units ranging from one planning unit per national forest to a total of 16. Four planning units per forest is about the average. The process outlined is the "typical" national forest planning process with an indication of the type of public response expected at the various steps in the process.

1. ESTABLISH PLANNING OBJECTIVES AND UNIT OBJECTIVES.

The land manager and the planning team get together and determine what it is that they want the land use plan to accomplish. At this point they announce to the public that land use planning is about to start on this particular planning unit, identify the expected timetable for the process, and ask the question, "Do you know something that we should consider in developing the plan for the unit?"

Resource analysis units or ecological land units are identified for the study area. These units are generally passed on soil and vegetative characteristics found on the planning unit.

2. DEFINE ACTIVITIES THAT CAN TAKE PLACE ON RESOURCE ANALYSIS UNITS.

The Planning Team determines various activities that can occur on the unit; activities like campgrounds, timber harvest, grazing, water yield improvements or water quality improvements. As they identify the activities that can take place, they also look at the inventory of land capability and environmental constraints, and develop rules for the conduct of the activities that they propose so that the activities will be conducted in an environmentally sound manner.

It is at this point that they ask some questions to the interested public: "How do you think this area should be managed? Does the land have some limitations that we might not be aware of? Are there some interactions between and among these resources that may limit different activities?"

The planning team will then identify the consequences of various activities, and how these consequences would affect resource outputs or use opportunities.

3. CONDUCT UNIT ANALYSIS.

At this point, the team establishes alternative sets of objectives and constraints for the entire planning unit, and calculates levels of output associated with each alternative set of objectives and constraints.

In doing this they might also calculate the number of acres devoted to each activity required to meet the levels of product output and use opportunity identified in the objective establishment step. It is at this point that the question: "Are there other ways to manage this land?" is asked.

4. CONDUCT ENVIRONMENTAL ANALYSIS.

The planning team using the unit analysis information developed in the previous step will identify on a map the location of these various activities, and display how the area would be allocated to various uses. They are then able to evaluate the social, economic, and environmental consequences of the alternative land use arrangements. The public is then asked: "Have we considered all of the factors in these alternatives?"

The public contact up to this point has generally been on an informal basis, frequently with letters, news releases, or working with various interest groups. Even in remote rural areas, it is not too difficult to get a spectrum of interest group participation at this stage of land use planning. We have had limited success in the use of public meetings as a public participation activity in the land use planning process.

5. DRAFT ENVIRONMENTAL IMPACT STATEMENT.

This is the first step where formal public involvement is required by law. The Draft Environmental Statement is submitted to the Council on Environmental Quality (CEQ) and then released for public review. The Draft will contain a discussion of the alternatives considered. It may or may not have a preferred alternative. The public generally has 30 to 90 days to review the Draft and comment to the responsible official.

6. FINAL ENVIRONMENTAL IMPACT STATEMENT.

This document is also submitted to CEQ and then released for public review. It will contain a proposed action, analysis of alternatives, and response to the public comment received in the review of the Draft statement. It is the responsibility of the responsible officer to consider public comment and make any necessary adjustments in the proposal. He must wait at least 30 days before implementing the decision. This period allows the public to respond to the proposal, and for him to make any minor modifications that may be appropriate prior to the next step.

7. It is at this point that the land manager finds himself "the man in the middle". He has made a decision that probably will not please everybody. In fact he may come to believe that it did not please anybody. If that is the case, we go to step eight.

APPENDIX 5

CASE STUDY #2

LAND USE CASE STUDY

Several years ago you and your wife purchased a four acre parcel of land along a river, opposite a federally owned forest. At the time of your purchase you decided to hold the land until you retired and then build a small retirement home. Currently there is no dedicated right-of-way for access.

Time has passed and you now decide to develop the property for your retirement. You would like to build a small one-bedroom home on half the property and give the remaining two acres to your daughter. Since you are on a river, you would like to have a small boat dock so that you can tie up a row boat that you plan to use for fishing.

What are the permits, cost, and time restrictions on building your retirement home?

OWNER: Visit local planning department to determine zoning and what permits are necessary.

PLANNING DEPARTMENT: Your land is currently zoned "forest protection". You cannot build on lot sizes less than 40 acres. If you wish to develop you have two alternatives:

- a. You may request a plan amendment to allow small lot development as a conditional use under the plan designation, or
- b. You may request the plan be amended and have the area redesignated as rural housing.

OWNER: You complete the necessary paper work and the Planning Department sets a hearing for your proposed amendment.

ALL: Discussion of the proposed amendment.

RESULTS: Plan amendment granted.

OWNER: Meet with the Neighborhood Advisory Committee to discuss your proposed development. This committee will make a recommendation to the Planning Commission on your proposed request.

NEIGHBORS: Discuss the proposed development with the owner.

OWNER: Having obtained the necessary plan amendment, the land must be rezoned. Owner goes before the Planning Commission to request a zone change so the zoning will be in compliance with the amendment.

PLANNING COMMISSION: The owner has presented his zoning request to the Planning Commission through a hearing officer. The hearing officer recommends that the zone change be granted. Before acting, the Planning Commission calls upon the neighborhood organization for their comments.

NEIGHBORS: Present their opinions to the Planning Commission.

PLANNING COMMISSION: Rules on zone change request.

RESULTS: If the Planning Commission denies your request you may appeal to the Board of County Commissioners. If they in turn deny your request you may appeal to the County Circuit Court through a writ of review. At the same time you may also appeal to the Land Conservation and Development Commission.

COUNTY BOARD OF COMMISSIONERS: Review applicants request for a zone change. If they deny continue as follows:

LAND CONSERVATION AND DEVELOPMENT COMMISSION: Petition is registered before the Land Conservation and Development Commission. Within 10 days notice of hearing is filed, and then applicant appears before a hearings officer. Hearings Officer makes recommendations to the LCDC which makes a ruling. The LCDC may rule on the appeal, set additional hearings, refer the petition back to the hearings officer or postpone decision at this time.

COURT: If petition is denied, you may take your appeal to the courts for final decision.

ZONING/APPEAL GRANTED: At the time that the zoning request is approved, applicant continues.

OWNER: Prepare preliminary plot plan with architect. Also complete paper work to subdivide your property.

PLANNING COMMISSION: The Planning Commission has the authority to control and regulate specified divisions of land by administrative procedure, major and minor petitions are reviewed by the Planning Commission and/or hearings officer. Planning Commission rules on the subdivision of the applicant's land.

OWNER: You are now ready to proceed to acquire your building permits.

PLUMBING PERMIT: A plumbing permit is required for installation, construction, or repair of any plumbing or sewage system, water supply system, sewage disposal system, etc.

ELECTRICAL PERMIT: Before any electrical materials may be installed or repaired, a permit must be obtained.

HEATING AND VENTILATION PERMIT: Same as above.

BUILDING PERMIT: Same as above.

OWNER: You are now ready to build, but you have no way to get onto your property so you request the Planning Commission to dedicate a small portion of your land as a permanent right-of-way from the adjacent county road.

PLANNING COMMISSION: Review application for the access right-of-way.

OWNER: Receives permission to have access right-of-way. You must now obtain a permit to construct your driveway.

DRIVEWAY PERMIT: You need a permit to excavate for construction or reconstruction of a driveway or sidewalk, and a permit for material filling or excavating in the street area adjacent to the county road.

OWNER: You are too distant from urban sewer service so you will have to install a septic tank system. You must obtain the necessary permits prior to construction.

DEPARTMENT OF ENVIRONMENTAL QUALITY: A permit is required for construction of all subsurface sewage disposal systems. Applicant is required to obtain or provide:

1. Site evaluation and land feasibility study;
2. Construction permit; and
3. Certification of satisfactory completion.

OWNER: You had originally planned to take water from the river; however, you learn this will not be permitted. Therefore, you need a water supply permit.

BOUNDARY COMMISSION: The Boundary Commission has the authority to grant approval for a water supply permit.

OWNER: A student research group has located a potential wildlife habitat on the federal lands opposite your property.

ENVIRONMENTALISTS: Seek out federal owners and request that the land opposite your proposed home be set aside as a scientific and natural resource area. They are concerned that your home will prevent full utilization of the federal lands for the wildlife reserve they propose. As a result, they bring a law suit challenging the adequacy of the environmental impact statement that you prepared. Proceed to courts.

COURTS: Owner and environmentalists present arguments. If you win all appeals, commence building. If you lose, try finding a condominium for your retirement home.

OWNER: You need to obtain a drilling permit for both the test water hole and the well from the county engineer.

OWNER: You just learned that a permit is necessary from the Fish and Game Commission

FISH AND GAME COMMISSION: Approval of the Fish and Game Commission is necessary for all developments along waterways. This approval would apply to your dock and possibly your house depending upon how close you build to the river.

OWNER: You need permits to put in utility poles for electricity and lighting of the driveway. Apply to the County Engineer.

OWNER: You need permits for cleaning up along the river banks for your dock and to improve the landscape.

DIVISION OF STATE LANDS: A permit is required from the Division of State Lands for fill or removal of any material from the beds or banks of any waters of the state as well as a lease agreement for submerged or submersible lands.

OWNER: You need to put in a bulk oil storage tank for heating your home. The following permits are necessary:

- BULK OIL STORAGE PERMIT
- FIRE ALARM PERMIT
- LIQUID STORAGE TANK PERMIT - STATIONARY
- CITY FIRE MARSHALL INSPECTION AND CERTIFICATION

PLANNING COMMISSION: Owner presents plans to the Planning Commission and Neighborhood Organization for design review. Collectively determine beauty.

OWNER: The Planning Commission asks if your plans for the boat dock have been approved by the Corps of Engineers. Owner remarks that he did not know it was necessary.

CORPS OF ENGINEERS: A permit is required for docks, dredging and filling. A public hearing will be required after you file your environmental impact statement.

ENVIRONMENTAL PROTECTION AGENCY: Review of Army Corps 404 Permit application and environmental impact statement.

ENVIRONMENTALISTS: Present comments at the public hearings.

SOME IDEAS FOR EDUCATION'S ROLE IN LAND USE PLANNING
(From the 23rd Conference of the Conservation Education Association)

Concerns About Land Use Planning:

Solid waste disposal

Soil capabilities for intended use

Water quality and quantity

Green space

Stimulating an appreciation among people of all ages - of land as a precious and limited resource

Development of a land use ethic - on various levels (personal, local, statewide, national, international)

Awareness of the variety of attitude held toward use of land

Inappropriate use as regards proximity to waterways

Industrial development in valleys where smog can develop

Location of roads near rivers

Use of bottomlands for housing

Destruction of watershed

Lack of planning for set-aside areas for wildlife

Preservation of good agricultural lands

Restriction of development in flood plains

Uncontrolled urban sprawl and related problems of providing services

Development not following capability of land

General public apathy to planning and environment

Population growth

Food production

Sufficient quality water

Concerned that special interests and power structures will get more into it than the general public and/or ordinary citizens

Concerned that communications between planning groups and general public may be poor to downright bad

Concerned that real estate brokers and land developers may try to pack the planning system with people favorable to their viewpoint

Concerned that some special bodies like U.S. Army Engineers and State Highway Departments will disregard or not coordinate with local planning

Extensive land use for energy generating plants and resource recovery areas

Transportation demands on agricultural areas

Housing developments on "scenic" land

Using land to its best advantage and capability is important

Maintaining the property rights of land owners is also important

Process for developing best use

How do we determine what is best use?

A change in the land ethic of U.S. citizens (the stewardship concept)

A social device must be developed to provide compensation to the property owner who is restricted in even reasonable development of his land because of restrictions society has imposed
 Need to preserve agricultural land, but it is not economically good to do so for the landowner - so he says, "How do we solve this?" (especially near urban areas)
 The need for open space (natural) near urban areas. Easements acquisition and lack of initiative on the part of government entities
 The desire to have routine species in our cities, along street edges, etc.
 The need for motorcycle areas in the near urban areas
 Developing awareness of consequences of various programs
 Developing concern
 Stimulating desire for action
 Teaching methods of gathering data
 Teaching ways of effective action
 Teach limiting factors - carrying capacity, costs of exceeding carrying capacity
 Develop land use planning committees in service organization
 Provide training for media representatives
 Provide training for government representatives
 Constituency for land planning
 Attend community meetings
 School project of current planning issue in community
 Workshops for public and interested groups in land use planning
 Join interested groups
 Your own lifestyle
 Develop a constituency for land planning
 Not enough real citizen input at early stages of decision making
 Public hearings at the end of the process seems to lead to various conflicts
 Agriculture allocations
 Government control of private land (why and how)
 Education in schools about land use and conservation
 That the land can be used to its fullest extent without destroying it
 That people are aware of what the land can take - how much before it is too much use
 Comprehensive community development rather than unplanned sprawl
 Concern for open-space and recreational outlets for communities
 Preservation of agricultural land
 Rapidly-growing communities - Bedroom communities for industry and university areas
 Balancing uses to maintain primary and secondary uses vs. tertiary industrial transportation
 Sewage treatment and garbage disposal area are overloaded

Individual rights vs. regulations

Identifying and saving prime farm lands

Flood plain construction

Prime and unique land

Prime agricultural land

Construction of roads, public service facilities, residences, shopping and business centers, industry

Indiscriminate loss of productive land to non-agricultural uses

The dominance of the dollar as the major decision maker in land use

While individuals are entitled to freedom (to a degree) in the use of their property, they have a larger responsibility to future generations

The need to balance the needs and desires of society with the collective willingness to absorb the costs involved

IDEAS FOR EDUCATION'S ROLE IN REDUCING OR ELIMINATING THESE CONCERNS

Education of youth to combat problems of land use. This is done most effectively by concentrating on improving teaching techniques, i.e., college training.

As a citizen, one can contribute to better land use planning by: a) keeping informed on facts and issues; b) attending meetings related to planning; c) teaching planning in the classrooms, and talking planning to civic and social groups. (also, promoting funds, workshops and tours dealing with planning)

Involving young people with real life situations within their own community. (Fact building, information sharing).

Develop awareness among young people - foster new attitudes toward LUP, develop awareness of community problems, land use problems. Teach political aspects as well as biological.

Source of needed information, student participation in data collection (formal/non-formal), participation in public hearings.

The land use planning concept is misunderstood by many people. There is a concern that misunderstanding and/or ignorance will weaken the effect of LUP.

Create public awareness.

Land use tours. Public forums - energy parks!

Find out how to find out what land use planning meetings and activities are going on in my area.

CLIMATE AND AIR QUALITY

Climate is a basic aspect of man's environment. His food supply, his shelter, and his clothing are determined by the climate in which he resides. It has been generally accepted as an aspect of the environment which must be endured, but man's activities can, and often do, affect local and global climatic patterns. Although efforts to modify these patterns have seen limited success, studies indicate that climate modification may be more successful in the future.

Although these modifications may have positive effects, some of our activities have definitely caused negative results. The "greenhouse effect" has become a common concern as carbon dioxide and particulate matter have increased. "Albedo," a relatively new term referring to the percent of incoming solar radiation that is directly reflected outward is heard more often. This seems to be affected by urbanization, agriculture, clear-cutting, and other human activities. Our extensive use of fossil fuels has a multiple effect on climate. As the changes in life-style occur, changes in climatic patterns are obvious. Consider the desertification of the Sahael; consider the results of smog on animal life; consider man's health and his quality of life.

CONTENT

The earth spins at about 100 mph while it circles the sun at 6500 mph. The sun is capable of holding the earth in orbit with its great mass. The mass of gases exploding in the sun gives the earth its source of heat and light. The earth's trip around the sun causes winds, precipitation, seasons, and many animal and plant cycles.

The sun is estimated to be 25,000° F.

Only about 1% of the sun's energy reaches earth.

Only 1/20 of the sun's energy is used in making rain fall.

Only 1/5,000 of the sun's energy is changed into chemical energy by plants.

In about 2½ minutes a year, we are using up 3½ days worth of sun energy which is bound up in oil and petroleum.

There is more sunshine, and thus warmth, over the equator than over the poles. Warm air rises in the tropics, and cool air moves in under it from the poles causing winds.

STUDENT OBJECTIVES

The student will be able to:

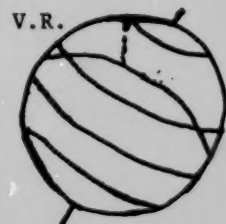
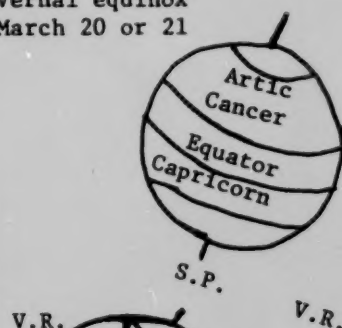
Identify the sun as source of the earth's energy and major influence on climate and weather.

Differentiate between weather and climate (climate = the average weather condition in a given region; weather = the day-to-day atmosphere changes in any given region).

Explain the causes of climate and weather.

Explain changes in day length and seasons (ex., equinox).

Vernal equinox
March 20 or 21



Autumnal equinox
September 22 or 23

STUDENT ACTIVITIES

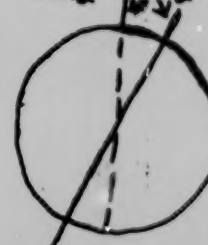
Discuss relationships of sun to earth, including:

Heat energy
Light energy - chemical energy
laws of thermodynamics
Climate
Seasons

Record temperature and precipitation each day for one week using daily newspaper weather map to correlate this data with highs, lows, and pressure systems.



Winter Solstice
December 22 or 23



Summer Solstice
June 21 or 22

RESOURCES

Israel, Saul; Douglas C. Johnson; Denis Wood. World Geography Today. Holt, Rinehart, and Winston, New York, 1976, pp. 3-6, 15-22.

Desk maps for students illustrating climate belts.

Newspaper weather maps, TV and radio reports.

Globes

Pounds, Norman J. G., and James Woodall Taylor. World Geography. 8th ed., South-Western, Pelham Manor, New York, 1974, pp. 40-49.

CONTENT

The rotation of the earth disturbs these basic patterns and breaks the air masses into areas of high and low pressure. Air circulation patterns result.

As the earth, a sphere, rotates, its speed varies along its surface from zero mph at the poles to about 1,000 mph at the equator. This changes the heat distribution on the earth's surface. The air in which we live is warmed, displaced upward by the cooler, more condense air, then sinks to the earth's surface. This vertical movement of air occurs in 6 major cycles (see diagram).

These factors cause seasonal and geographical variations in wind and weather.

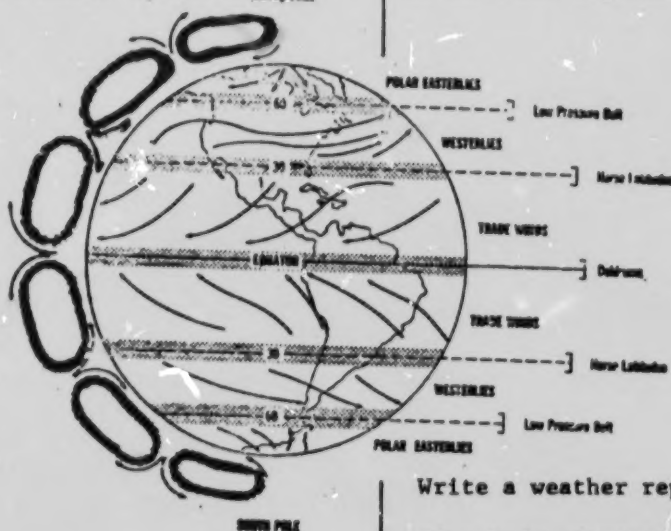
Natural geography and manmade environments also effect air patterns and weather (ex., large bodies of water, cities, high buildings, hills, mountains, etc.).

Water and soil differ in ability to retain heat. Where land and water meet, the air is unevenly heated. During the day, the cooler air over the water flows in toward the land and displaces the warm air upward. During the evening, it is reversed, the cooler air over the land flows

STUDENT OBJECTIVES

The student will be able to:

Explain general climatic air movements around the globe and their causes.



Explain several factors that affect air currents such as sea breezes.

STUDENT ACTIVITIES

Draw a diagram showing the air patterns and indicate the causes. Draw in climatic regions.

Write a weather report.

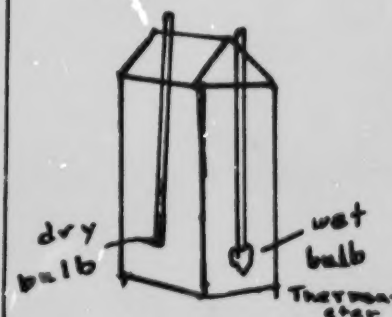
If a body of water is nearby, check the direction of the air currents during the day and at night. Check temperature of soil and water for day and night. Illustrate your findings and explain how these air currents can affect air pollution.

Invite a person from the local weather station to come to class and explain the affects of regional air temperatures and currents on air quality in your area.

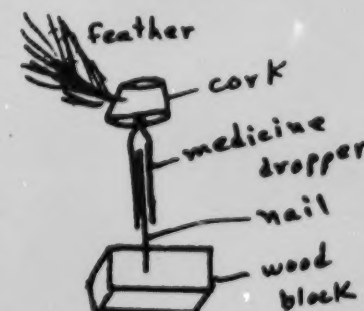
RESOURCES

Climatic transparencies
Individual desk maps

Hygrometer to measure humidity



wind vane



CONTENT

out to sea under the warm air. Such breezes affect air pollution.

Moisture in warm air condenses near the cool ground resulting in fog or mist.

Concentration of water, ozone, and cloud cover can also effect atmospheric temperature and thus climate.

Some scientists believe that the increase in pollution will decrease the amount of sun light and heat coming into the earth and thus have a cooling effect.

Increasing CO₂ may cause a "greenhouse" effect resulting in an increased heat melting of polar ice, etc.

Clear-cutting, increased clearing of land for housing agriculture, highways, and city suburbs tend to increase the CO₂ in the air.

Burning of fuels for energy and many human activities also increase CO₂ and heat.

STUDENT OBJECTIVES

The student will be able to:

List human activities that can cause changes in weather, possibly affecting world climate.

STUDENT ACTIVITIES

Debate: Global climate—an ice age or desert in the future?

Debate: Particulate as a cause of atmospheric cooling or heating?

Research and report on the possible effects of solar units on climate—local and global.

Discuss or debate: Effects of SST and/or ozone concentration on the climate.

Consider all of your daily activities. Describe how each affects the climate. Keep a notebook for one day; record any effects you had on the climate or air in your locality.

Construct a chart listing all factors that could affect climate and how (ex., air conditioning, a new shopping center, electric appliances, strip mining, using coal instead of oil, etc.).

RESOURCES

CONTENT

Fall weather conditions of warm days and cool nights favor formation of bright leaf colors. Sugars made in the day cannot move out of a leaf at night if temperature is below 45° F. This results in formation of chemicals such as anthocyanin (red) that give leaves their varied colors.

Altitude also effects weather and thus food production.

Data indicates that the climate of cities differs significantly from rural areas.

Cities give off tremendous amounts of heat, from industry, homes, vehicles, etc.

Tall buildings change wind patterns.

STUDENT OBJECTIVES

The student will be able to:

Relate changes in seasons and weather conditions to changes in living things (ex., bird migration, leaves changing, etc.).

STUDENT ACTIVITIES

Record date of the longest night, slowest growing season, harsh cold, snow, what happens to food stuff, pond waters, insects, etc.

Check soil temperature and water temperature and put on calendar. List all changes you observe in plants and note them also. Check air temperature, precipitation, humidity, and wind direction. (Try constructing your own equipment.) Relate changes in living things...plant blossoms, bird migrations, etc.

Set up a cooperative arrangement between yourself and another student from a school in a different environment. (Ex., if you are in a city school, contact a student in a rural school.)

Arrange to check temperature and humidity at a set time each day for two weeks. Determine differences between the urban and rural environment.

RESOURCES

Jones, Stephen, and Marion F. Murphy. Geography and World Affairs. Rand, McNally and Company, New York, 1976, p. 182.

Pounds, Norman J. G., and James Woodall Taylor. World Geography. 8th ed., South-Western, Pelham Manor, New York, 1974, pp. 190-206.

CONTENT

Pavement and solid structures such as roofs cause rain to run off. Soil retains rain, and the moisture evaporates from soil and vegetation to cool the air. This is not so in the cities.

Cities release great quantities of particulate matter into the air and larger amounts of CO₂ which combine to form a "greenhouse" effect.

As a result, the city is an island of hot air...an island of dirty air which has difficulty escaping from the "greenhouse."

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

Determine and list the characteristics of a city that could modify weather. Explain the effects of weather at a farm 10-20 miles down-wind from the city.

Using pictures of a clean city and a smoggy city, discuss which one you prefer and why. Determine the population of a given area of your city or town. Determine the amount of green space or parks in that area. How much green space is there per citizen? The total oxygen requirement of a community of 1,000 people can be balanced by a 440 acre park. What percent of the total urban land you studied is developed as park or green space? Is there an even balance between O₂ user and releaser?

Collect pictures to show differences between rural and urban areas. Make into scrapbook, collage, bulletin boards.

RESOURCES

Magazines and newspapers.

Variable

Urban levels compared to rural

Pollutants	
Particulates	10 times more
Gases (sulfur dioxide, carbon dioxide, carbon monoxide)	5 to 25 times more
Cloudiness and fog	
Cloud cover	5 to 10 percent more
Winter fog	100 percent more
Summer fog	30 percent more
Precipitation	
Rain	5 to 10 percent more
Snow	5 to 15 percent less
Relative humidity	
Winter	2 percent less
Summer	8 percent less
Solar radiation	15 to 20 percent less

CONTENT

STUDENT OBJECTIVES

STUDENT ACTIVITIES

RESOURCES

The student will be able to:

Temperature

Annual mean

0.5 to 1.0° C higher

Winter average

1 to 2° C higher

Visibility

5 to 30 percent less

Wind speed

Annual mean

20 to 30 percent less

Calms (stagnant air)

5 to 20 percent more

Source: Landsburg, 1970, p. 372, as obtained from
Miller, G. T., Living in the Environment: Concepts,
Problems, and Alternatives, page 190.

AIR

Air is a mixture of gases, solids, and liquids that make up our atmosphere. Some substances in air are essential for life but can be detrimental if they occur in high concentrations. Some air particles are natural and some manmade.

Air is a renewable resource. Natural processes continually recycle and renew the important parts of air. Carbon dioxide is absorbed and used by plants, and oxygen is released. Oceanic plankton is the greatest producer of oxygen. Nitrogen is also taken from the air by bacteria and is used by plants, and then is released back to the air by action of bacteria and decomposition. These natural cycles, along with wind patterns, renew the air.

Air is essential for many of man's activities--industry and human activities depend on energy. Presently, most of this energy comes from fossil fuels which must be burned to release energy. Burning requires oxygen and produces carbon dioxide, water, and other substances which can pollute the air.

Nature has also been a major air polluter...volcanoes, dust storms, forest fires, etc. Of these, volcanoes are the greatest polluters of air.

South Carolina is working hard to maintain good air quality. Our sampling stations located throughout the state are reporting some problems, but all in all, it looks good in South Carolina. We need to keep it that way.

CONTENT

Air is essential for all living things.

Air is an invisible, odorless mixture of gases containing about 78% N, 21% O and argon, CO₂, and traces of other substances.

Air pollution has been defined as the presence in air of one or more contaminants such as dust, mist, fumes, gas, odor, smoke, or vapor in quantities and of duration to be injurious to human, plant, or animal life or to property, or which unreasonably interferes with the comfortable enjoyment of life and property.

487

STUDENT OBJECTIVES

The student will be able to:

Describe air exchange mechanisms in plants and animals.

Define air and describe its composition.

Define air pollution.

251

STUDENT ACTIVITIES

Observe stomata on leaves, examine lung tissue and gills, and discuss the necessity of oxygen for life and life's activities.

Draw a graph showing the amounts of different substances in the air. Obtain data on amounts of substances in polluted air and compare a graph of clean air and polluted air.

List opposite word pairs that describe air (ex., fresh - polluted, clear - misty, still - windy, etc.).

Make a chart showing each major pollutant, its source, its effects.

RESOURCES

Miller, G. T. Living in the Environment, also Lung Association and EPA brochures.

488

CONTENT

Air is composed of natural and manmade substances. Some of these are beneficial to certain species and others are harmful.

Pollutants may be classified as gases and aerosols. Aerosols are suspensions of fine solid or liquid particles in the air.

Pollutants include:

Aerosols (particles)

Dusts - ash, bacteria, cement pollens, etc.

Smokes - fine carbon particles resulting from combustion.

Mists - particles from gas or vapor condensation (ex., fog).

Fumes - smoke particles resulting from combustion (ex., engine exhaust).

Volcanic dusts, cotton and asbestos fibers, fluorides, soot from fires, and metallic particles may be found in the air. Some of these are carcinogenic, and many cause severe damage to plants, animals, and materials.

STUDENT OBJECTIVES

The student will be able to:

Identify natural and man-made components in air and their potential effects on living and nonliving things.

Identify the major air pollutants and their causes.

Recognize the impact of combustion on air quality (ex., burning trash, burning cigarettes, etc.).

List dangerous particles in the air.

Define "Brown Lung Disease."

STUDENT ACTIVITIES

Darken the classroom and turn on a projector light. Note the small particles in the beam of light. These are some of the larger solid particles of air. Design a method for observing smaller particles, such as spreading a thin film of vaseline on glass slides and taping them to a variety of places to collect the particulate matter in the air. Examine them under the microscope to determine the number of particulates, and note the area of greatest pollution. Examine them for kinds of particulates. Try this at home and determine the place with the most dust.

Look up recent court decisions concerning Brown Lung Disease and find out what industries and jobs in your community may have people with the problem. Report on what is being done to prevent this.

RESOURCES

Projector, vaseline, slides, tape, microscope

CONTENT

Smog may be the result of visible smoke or fog or a combination of the two.

Photochemical Oxidants

Aldehydes (oxidized alcohols) resulting from combustion and ozone from aerosols can cause photochemical smog by reacting chemically in sunlight.

Oxides of Carbon

Carbon monoxide and carbon dioxide. CO is most heavy in traffic jams and in cigarette smoke. Usually, it comes from natural sources in rural areas. It is constantly being converted to CO₂.

Oxides of Nitrogen

Nitric oxide and nitrogen dioxide. NO₂ from vehicle exhaust can be extremely hazardous. Combined with particulate matter, the result is photochemical smog. Nitrogen oxides are produced naturally by bacterial action.

STUDENT OBJECTIVES

The student will be able to:

Define smog.

Identify those substances which are most damaging to air quality in your area.

STUDENT ACTIVITIES

Check for smog in your city using a Ringlemann Chart.

Check the air pollution in various parts of your house or school. Use a vacuum cleaner with a hose. Cover the end of the hose with a piece of filter paper fastened with a rubber band. Put the cleaner in the place to be tested and run it for 20 minutes. Move it to the next test location. Change filter paper, label it, and run another sample for 20 minutes. When all samples have been collected, compare filters and report findings.

Obtain a glass of limewater. Using a straw, blow into the limewater. Explain the change.

Contact the local health department and find out which of the following air pollutants are the most hazardous in your area: sulfur dioxide, photochemical smog, nitrogen oxides, hydrocarbon vapors, CO, lead bromide, dust, etc.

RESOURCES

Ringlemann Smog (refer to supply catalogues or DHEC).

Filter paper (coffee will do), vacuum cleaner.

Limewater, glass, straw.

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

OTHER ACTIVITIES

Interview the school's custodian and/or heating engineer. Obtain information concerning furnace and air conditioning equipment and filters. If permanent filters are used, ask permission to wash one and observe and collect the dirty water. Evaporate and weigh periodically to determine amount of particulates filtered from school air. Discuss ways to conserve energy and maintain clean air.

Use your knowledge of air pollutants and sources to make a list of the types of industries located in your community which might be responsible for the air classification level of the area. Once industries are identified, divide the class into groups to check out each industry.

- Prepare a set of questions to be used in the interview (they should be technically phrased with regard to ambient air standards).
- Invite a representative from a few selected local industries to meet with students and react to prepared questions.

RESOURCES

CHART

Contaminant	
Source	
Air Standard	
Positive Steps Taken by Industry	

Company

CONTENT

Oxides of Sulfur

Sulfur dioxide and sulfur trioxide. SO_2 reacts with O_2 in air to form SO_3 which reacts with water in the air to form sulfuric acid.

Most sulfur oxides come from combustion of coal--industry and electric utilities. As sulfuric acid, it is highly damaging to lungs, materials, buildings, etc. (by acid rain).

Hydrocarbons

Benzene, methane, etc. Result from partially burned gasoline. Some are carcinogenic, and they contribute to photochemical smog.

Major sources of pollution:

Combustion: transportation; industry; power plants; fires--forest, waste, agriculture; vaporization of hazardous liquids.

How gaseous wastes are disposed affects the quality of life.

Geographic location, industry, and people affect the air quality of the region.

495

STUDENT OBJECTIVES

The student will be able to:

Describe effects of "acid rain" on buildings, tomb stones, and other materials in the area.

List major sources of air pollution.

STUDENT ACTIVITIES

Construct a chart to organize data.

Take a field trip to a city cemetery and look for evidence of air pollution in the area.

Discuss or debate: Return to coal as the major energy source. What will that do to air quality? How will cleaning it up affect cost of energy? Should our emphasis be on a return to coal? What form? Discuss coal gasification and the law of thermodynamics that states that with every change from one form of energy to another, there is an energy loss.

RESOURCES

496

CONTENT

People must look at alternatives and decide to change activities or use anti-pollution technology. Nuclear energy is one alternative. It may result in one form of pollution and reduce other forms.

Air pollution may be classified as to source:
point source--ex., one factory chimney or one pile of trash burning.
line source--ex., vehicles on highway.
area source--ex., city or industrial park.

Air pollution is not restricted to any given local area. It is regional, national, and international.

STUDENT OBJECTIVES

The student will be able to:

Describe alternative energy decisions that affect air quality and life-style.

Identify and give examples of the type of pollution sources.

Explain why air pollution is not just a local problem.

STUDENT ACTIVITIES

If most power companies burn coal, and the sulfur oxides and particulates increase to a dangerous level, what measure would you be willing to take in changing your life-style to reduce amounts of electricity?

Would you favor monetary incentives, peak load incentives and pricing, government control, switching to nuclear, other. Explain.

While traveling to and from school, see if you can spot an example of a point source, line source, and area source of pollution.

Compare this with point and non-point sources of water pollution.

Note whether each source of air pollution is instantaneous or continuous. Ex., line source may be present only at certain times of the day when traffic is heavy; factory source may be continuous all day and all night.

RESOURCES

See water unit.

CONTENT

Air pollution is interrelated with water and land pollution.

Air pollutants do not stay at their source but move according to wind direction and natural and man-made conditions. Turbulence, size and weight of particles, and temperature gradients all affect movement of air pollutants.

Smog has been measured in high concentrations 50 miles or more from its urban source. In some areas pollution levels are higher in the country than in the urban source area.

Weather determines distribution of pollutants.

499

STUDENT OBJECTIVES

The student will be able to:

Explain how air pollution is interrelated with water and land pollution.

Explain the movement of air pollutants in the area.

257

STUDENT ACTIVITIES

Draw a diagram to show how air pollution is interrelated with water and land pollution. You might wish to look at water cycles.

Identify all the major sources of air pollution in your area. Obtain data concerning usual wind and flow of air currents. Predict the direction of flow of air pollutants from the sources. Devise a method to check your hypothesis. Draw the shape of the smoke or area of air pollution. (Ex., York County has pollution problems because it is downwind from Charlotte, North Carolina.)

Write a paragraph describing what you think is meant by the statement, "Everything must go somewhere but there is no way."

Obtain two jars with lids. Punch holes in both lids. Put a candle in each jar and light them. Put lids on and place one jar in a protected area with little air in circulation; place the other in a breezy window. Leave for 30 minutes. Observe and record results.

RESOURCES

Miller, G. T. Living in the Environment, p. 31.
Barry Commoner Resource.

Two jars with lids
Two candles, matches

500

CONTENT

An inversion is an increase in temperature with altitude. The inversion acts as a lid preventing pollutants from rising. When there is little or no wind, polluted air may build up over a large area and remain for days.

501

STUDENT OBJECTIVES

The student will be able to:

Explain an inversion, its causes and effects.

258

STUDENT ACTIVITIES

Build a model to illustrate an inversion and explain it to the class. Cite instances of health problems due to inversions.

Example: 2 cold bottles and 2 warm ones. Burn a piece of paper in the cold one and put a warm one over it. Then burn a piece of paper in a warm one and put a cold one over it. Before the experiment, predict the results, then compare your prediction with what you observed. Discuss.

RESOURCES

Inversion model experiment on pp. 278, 279.

Four bottles, ice, a heat source, and matches.

502

AIR AND HEALTH

Clean air is essential to life.

Dirty air makes eyes water, burns throats, and stifles lungs. Gases containing sulfur, nitrogen oxides, sulfuric acid, and photochemical oxidants irritate the respiratory system causing coughing, chest discomfort, and impaired breathing. Carbon monoxide interferes with the ability of blood to carry oxygen because heart and nerve tissues are particularly susceptible to oxygen deficiency. Carbon monoxide pollution can seriously impair coronary and central nervous system functions.

eg. December 1952. London, England. Temperature inversion held the city's air close to the ground, and an anticyclonic high pressure system prevented the formation of winds which would have dispersed the pollutants that were accumulating. Duration: 5 days. Result: 4,000 more deaths than normal for a five-day period; 48% higher hospital admissions; 84% of those who died had pre-existing heart or lung disease.

eg. 1948. Donora, Pennsylvania. Population: 14,000. Fifteen to 20 more deaths than normal; more than 6,000 of its residents adversely affected; 10% seriously.

eg. 1953 + numerous occasions. New York City. More than 200 deaths above normal.

Air pollution disasters like those listed above are alarming, but even more serious are the effects of long-term exposure. South Carolina also has some of the same climatic conditions and human activities that combine to form critical buildups of pollutants. Statistics indicate that smokers more frequently suffer from emphysema and chronic bronchitis which are significant causes of disability. Air pollution causes changes in heart and lung functions. Even nonsmokers suffer. Children especially suffer a high risk of developing lung disease. Studies have shown significant association between specific air pollutants and death rates across a large number of cities in the United States. Brown Lung Disease has affected many persons who are textile workers. How many South Carolinians have diseased lungs due to cotton dust?

CAUSE	EFFECT
Carbon monoxide (traffic)	Impairs vision, produces headaches, places strain on heart deficiency.
Asbestos fibers	Asbestosis, brochogenic cancer, and other malignant diseases--some developing up to 30 years after exposure.
Beryllium (used in rocket fuels)	Lung disease.
Mercury (from batteries, paint, pulp, etc.)	Affects central nervous system, leads to weight loss, insomnia, tremors, and psychological disturbances.
Lead (lead dust from motor vehicle emissions)	Neurological impairment, seizures, mental retardation, and behavioral disorders.

Air pollution has existed for hundreds of years and actually could go back as far as the discovery of combustion. Only when air, usually a colorless, odorless, and tasteless substance, develops unpleasant color, odor, and taste do we notice it and become concerned.

One of the major causes of pollution is the automobile. Therefore, one of the most necessary actions to curb air pollution is a change in attitude and values and, thus, life-style as it concerns use of the private car.

CONTENT

Some pollutants cause more damage than others.

All pollutants are not visually perceptible.

Substances in polluted air affects the health of all living things. They also can affect nonliving materials.

Some living things have developed tolerance to some pollutants in air.

NATURE POLLUTES.
INDUSTRIES POLLUTE.
INDIVIDUALS POLLUTE.
AGRICULTURAL ACTIVITIES POLLUTE.

597

STUDENT OBJECTIVES

The student will be able to:

Describe long-term and short-term effects of pollutants on humans.

List some air pollutants which cannot be detected by sensory perception.

Identify and list different effects of polluted air on specific plants, animals, and humans.

Explain a diversity index as it relates to air pollution.

Identify different points of view regarding air pollution.

261

STUDENT ACTIVITIES

Check the library and determine which plants are good environmental indicators. Obtain several of these and place them in different places for one week to determine the area of greatest pollution in your town. Example, tobacco is used as an indicator of ozone.

Find out what the major polluters are in your local area, in the state, and in the nation.

Obtain lung tissues from veterinarians, city pounds, museums, hospitals, etc. Examine them for evidences of air pollution.

Fact or Fancy: Find information to support or refute the following:

1. Most of our O_2 comes from photo-dissociation of water in the air (not from plants which use what they produce).
2. CO gas is not increasing in spite of increase in number of cars and combustion. Bacteria use it to enrich soil.
3. Most oxides of nitrogen come from nature not man, about 97% natural. Therefore, they cannot be totally removed.

RESOURCES

Air Pollution Primer.
American Lung Association.

DHEC

"The Eight Surprises or Has the World Gone to Hell?" by John J. McKetta, Department of Chemical Engineering, University of Texas, Austin, Texas 78712.

508

CONTENT

Evidence indicates that the photochemical smog is caused by exhausts from motor vehicles. Vegetation also contributes as indicated by the Indian Summer haze and the famous "smoke" of the Smokey Mountains.

599

STUDENT OBJECTIVES

The student will be able to:

Recognize the impact of the car on air quality.

Describe alternatives relating to use of cars and transportation as they affect air pollution.

STUDENT ACTIVITIES

4. The late William Pecora reported that all of man's air pollution during his thousands of years of life on earth does not equal the amount of particulate and noxious gases from just 3 volcanoes--Krakatoa, Mt. Katmai, and Hekla.

5. Lead in gasoline does not cause harmful air pollution. Aromatic substitutes are carcinogenic. Be sure to obtain information from a variety of sources--auto industry, EPA, universities, etc.

Car engines release into the air about 700 grams of CO for each gallon of gas consumed. Calculate the amount of CO emitted by your family car during one week...one year.

Suggest alternatives to auto-caused pollution. Design a values identification activity to determine choices (ex., small car vs. large car, public transit, etc.).

RESOURCES

510

CONTENT

In 1968, the Columbia area of Richland and Lexington Counties contained 119,729 autos. In 1977, there were 201,272.

In 1968, Greenville had 108,155 cars; in 1977, 157,010.

In 1968, Charleston had 89,512 cars; in 1977, 129,024.

Evidence indicates that motor vehicles contribute as much as 85% of the cost of pollution.

"Considering ecosystem disruption, displacement of land for garages, highways, and parking lots, the loss in property values, traffic safety and insurance costs, the costs of streets, highways, and driveways, pollution costs, health costs, and added welfare costs because the poor can't get to jobs, it is estimated that each United States automobile costs the public at large about \$1 per mile."

STUDENT OBJECTIVES

The student will be able to:

Explain a change in air quality based in part on the increasing number of cars on the road.

Describe the cost of the individual private car and its impact on the environment and the economy.

STUDENT ACTIVITIES

Determine the increase in the number of cars in your area in the last 10 years. How does this compare with the increase in number of people? Use this information to relate to pollution. Project what your area will be like 10 years from now in 1988. Recommend policies to change the trend.

Debate: Ban the internal combustion engine by the year 2000.

Debate: Leaded or unleaded gas.

Through research and interviews, find alternatives to the car and suggest methods for implementing what you consider the best alternative.

Using cheesecloth over the exhaust of different makes of cars, tuned and untuned, large and small, design a controlled experiment to determine the factors resulting in the largest amount of particulate pollution.

Debate: Is there a credibility gap? Was the catalytic converter a mistake?

RESOURCES

Miller, G. T. Living in the Environment, page E 17 -1 -2.

Automobile Pollution and the Great Credibility Gap. Automobile Manufacturers Association, Inc., 320 New Center Building, Detroit, Michigan 48202.

CONTENT

Statistics indicate that the United States has approximately 7% of the world's population, yet consumes 30% of its resources and creates 50% of the world's pollution. Statistics indicate a need for global international resource management.

The aesthetic quality of a community can be adversely affected by air pollution.

Major problems resulting in poor air quality include:

1. Industrial Growth:
kind; location-clustered or widely dispersed
2. Urban activities:
traffic dust; wind-blown dust, leaf and trash burnings
3. Energy:
nuclear vs. fossil fuel, transportation--private auto vs. mass transit, products--natural vs. synthetics
4. Recycling:
reuse vs. burning or burying

STUDENT OBJECTIVES

The student will be able to:

Cite examples of resource interdependence among nations of the world. (Clean air is being considered a resource.)

Describe the aesthetic effects of air pollution in South Carolina and particularly in your town.

STUDENT ACTIVITIES

Divide the class into committees to check on the air pollution problem in other countries. Have each committee choose a country to check on. Find evidence in newspapers and magazines that environmental health is of international concern.

Set up a mock United Nation session to discuss the air pollution and health problems and recommend international standards and regulations.

Find out how other nations are disposing of nuclear waste. Show how this could become an air pollution problem.

Bring newspaper or magazine ads to class that relate to air pollution. Discuss if the values illustrated any basis and the credibility of the statements. Discuss how advertising and propaganda influence your decisions and life-style. How do they determine the aesthetic quality of your life.

RESOURCES

CONTENT

Air quality is the responsibility of the public.

All environmental regulations and standards are subject to public participation through mandatory public hearings.

515

STUDENT OBJECTIVES

The student will be able to:

Describe the relationship of the energy crisis to air pollution and the economy.

Identify ways students can help improve air quality.

265

STUDENT ACTIVITIES

Examine the alternatives to use of oil and gas...especially use of coal. Review the energy policy statement of the federal government. Explain how this can affect air pollution and how air pollution standards applied to energy can have an impact on the economy and the cost of energy to you at home.

Locate the air quality monitoring stations in your area. Find out what activities they perform. Find out if there are a sufficient number of stations and how students may help monitor air quality.

Find out if trash is burned or buried. Find out if burning leaves is permitted. What controls are mandated for burning and house and industrial smoke? Report findings to the class with recommendations for improved standards and ordinances.

RESOURCES

1977 Air Pollution Measurements of the South Carolina Air Quality Surveillance Network.
DHEC.

S. C. Air Quality Implementation Plan.
DHEC.

516

CONTENT

The 1976 EQ Index presented the following information:

Cost of cleanup of pollution - \$14.2 billion

Cost of pollution damages - \$12.3 billion

Net cost of cleanup - \$1.9 billion

Air pollution causes damage to health, property, and crops in the U. S. of more than 12.3 billion dollars per year.

It has been estimated that air pollution costs any person living in a city of over 50,000 from \$160 to \$320 per year.

The major costs are to health. Deaths from lung cancer and emphysema have been increasing.

People pay for air pollution in loss of health, property, and natural resources.

Smoking is a form of air pollution for those who don't smoke as well as those who do.

STUDENT OBJECTIVES

The student will be able to:

Describe the economic impact of air pollution.

Describe the effects of radioactive particles in the air.

List the kinds of things that are harmed by each major air pollutant. Example, sulfur oxides can harm people, vegetation, stone, paper, metal, fabrics, etc.

Nitrogen oxides can harm people, vegetation, and metal.

Describe effects of smoking on smokers and nonsmokers.

STUDENT ACTIVITIES

Research in library or write for data to show what impact air pollution has had on any one of the following economic factors:

1. medical costs
2. maintenance costs
3. damaged crops and livestock
4. real estate values
5. food bills
6. cleaning costs
7. equipment costs
8. absenteeism
9. aesthetic deterioration

Simulation game:
Auto manufacturer
EPA

Judge and jury of citizens

Auto manufacturer requests a delay in meeting the 1978 air pollution standards. Claims insufficient time to redesign vehicle.

Describe the cost to the individual of automobile pollution control devices. Interview various sources and read to obtain all sides of the question.

Invite a physician to class to discuss diseases attributed to smoking and air pollution, a vet on animals, a horticulturist on plants, etc.

RESOURCES

The Economics of Pollution.

Joint Council of Economic Education.

Another possible simulation p. 277.

CONTENT

THE ECONOMICS OF DIRTY AIR

Consider:

It tarnishes silver, rusts steel, damages metal buildings.

It dirties clothes, autos, and homes.

519

STUDENT OBJECTIVES

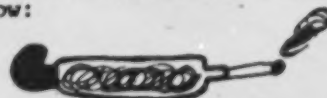
The student will be able to:

List at least 6 ways by which air pollution costs you \$\$\$\$.

267

STUDENT ACTIVITIES

Assemble materials as shown below:



Light cigarette. Squeeze vacuum bulb and count the number of puffs needed to smoke the cigarette to within one inch of the filter or end of cigarette. Remove glass wool, place in container and wash with alcohol. Pour into an evaporating dish and weigh amount of residue from the glass wool. This process may be repeated with different brands of cigarettes--filtered and unfiltered. Remove the glass wool each time and label the residue/alcohol solution of each cigarette. Compare results and discuss effects on lungs.

Take a field trip around your neighborhood or the school and list items of evidence showing the effects of air pollution on metal, buildings, stone, steel, etc.

RESOURCES

Vacuum bulb, glass wool, long glass tube, matches, evaporating dish, alcohol, cigarettes (different brands).

520

CONTENT

It kills, sickens and destroys. In one case in South Carolina, 14 persons went to the hospital.

It reduces the life of your house paint. Half the cost of repainting is due to air pollution.

It kills vegetation and reduces crop yield.

It wastes fuel from incomplete combustion. A fourth of the cost of your fuel can be wasted up the chimney.

It causes tires to crack and nylons to deteriorate.

It causes auto accidents due to reduced visibility.

THE COST OF CITIZENS OF SOUTH CAROLINA FOR AIR POLLUTION IS \$195 MILLION PER YEAR.

STUDENT OBJECTIVES

The student will be able to:

Describe the effects of air pollution on the body.

Relate air pollution and the Clean Air Act to economic growth and development in South Carolina.

STUDENT ACTIVITIES

Report on asthma, emphysema, colds, chronic bronchitis, heart disease, and lung cancer as they may relate to air pollution.

Find out the effects of pesticides or other pollutants on animals.

Check with the highway department to determine how many accidents have occurred during a time of poor visibility.

Interview or write for information from the South Carolina Development Board and DHEC to get views on the impact of developments on pollution in South Carolina and particularly in the area where you live.

RESOURCES

CONTENT

GROWTH OR POLLUTION: MUST WE CHOOSE?

Citizens must be aware of all alternatives. You cannot be against industrial development and more jobs and ignore the needs of the people for jobs, nor can you be for any industry regardless of the environmental impact.

According to some officials, the Clean Air Act and its amendments will hinder industrial growth.

The EPA says that there can be no significant deterioration of existing air quality.

For some, this means no growth. However, DHEC identifies only two areas in a no-growth situation--Georgetown and Charleston peninsula.

The Act could affect land-use planning and serve to spread development to many sparsely populated areas rather than concentrating it in any given location.

523

STUDENT OBJECTIVES

The student will be able to:

Relate pollution legislation to land-use regulations.

269

STUDENT ACTIVITIES

Report to class on the Clean Air Act. Include any standards and laws that exist, methods of enforcement, cost.

What agency established the 1970 Clean Air Act? What are ambient air standards? What role did the 1970 Clean Air Act play in setting ambient air standards?

Discuss land use planning and regulations as they have an impact on:

1. What you can do with the land you own.
2. On the health and welfare of South Carolina citizens.
3. On the economy and job opportunities.

RESOURCES

524

CONTENT

A new problem in South Carolina is photochemical oxidants and the resultant ozone. This becomes worse with increasing population and resultant increasing vehicle traffic.

525

STUDENT OBJECTIVES

The student will be able to:

Explain the Clean Air Act and where we are now as to legislation and regulation.

Explain the functions of the EPA in regard to air pollution.

STUDENT ACTIVITIES

Debate: to grow or not to grow (Oregon and a few other states have a no-growth policy.) Discuss how the "spread out" policy of the Clean Air Act conflicts with present land use method of zoning.

Relate growth to increasing population and vehicles and the resulting air pollution. Set up a referendum in school and, after explaining the situation, have all vote on a growth or a no-growth policy in South Carolina.

Write a report to give to the class on the Clean Air Act and where we are now. Include amendments to the 1970 legislation and actions that have been taken.

Debate: How clean is clean; where should we be concerning air pollution: Is additional legislation needed? Are different regulations needed? Explain.

Obtain information from the EPA to find out what standards they have set regarding air pollution. Find out what methods are used to enforce standards. Report on the EPA to the class.

RESOURCES

Clean Air. It's Up to You, Too. EPA, March 1973.

Latest EQ Index from National Wildlife Federation, 1412 16th Street, NW, Washington, D.C. 20036.

526

CONTENT

AIR QUALITY IN SOUTH CAROLINA

Air quality in South Carolina is checked constantly by the staff of the Department of Health and Environmental Control.

Air sampling stations are located in strategic spots all over South Carolina.

South Carolina has a problem with stagnant air masses as they contribute to air pollution. Increased urbanization and the related increased traffic are also major contributors to the problem.

527

STUDENT OBJECTIVES

The student will be able to:

Identify local air sampling stations.

Describe the data collected at local air sampling stations and understand the status of the air in their locality.

Describe air quality in South Carolina.

Describe the factors--climatic and human--that result in dangerous stagnant polluted air masses.

271

STUDENT ACTIVITIES

Visit the local air sampling station and find out what kinds of data are collected and the changes that have occurred in your area regarding air pollution.

Find out where daily samples are taken. What do the data show? Do they have a plan for an air alert? If so, what is it?

Write to the Air Quality Section of DHEC and find out the latest information on air quality in South Carolina. What is our major air pollutant? What is our major source of pollution? What is being done about it?

Interview a local weatherman to determine the kinds of weather conditions that result in stagnant air masses. Find out from the motor vehicle office the increase in vehicles over the past 5-10 years. Find out if there are any new industries in your area. Report on the potential for a dangerous air mass in your community.

RESOURCES

See sampling sites on page 280-281.

528

CONTENT

Major Problems in South Carolina.

1. Fuel burning: homes, businesses, power plants, industries, vehicles (vehicles are the major cause of haze over cities).
2. Outdoor burning of trash causes most citizens complaints.
3. South Carolina is subjected to a 45% chance of inversions on an annual basis.
4. Increasing population, cars, and industries.

Methods for improving air quality include:

1. Changing the process (ex., from burning trash to sanitary landfill).
2. Waste treatment and recycling (ex., by adsorption, absorption, combustion, chemicals, settling chambers, cyclones, scrubbers, filters, electrostatic precipitators).
3. Dilution and dispersion (ex., ample, tall stacks).

STUDENT OBJECTIVES

The student will be able to:

Describe air quality in his area and list methods for improving its quality if needed.

STUDENT ACTIVITIES

Collect and compare national with local air sampling data. What does this tell you about your area?

Field trip to incinerator, industrial plant, hospital tissue laboratory.

Identify local sources of pollution and find out what is being done to reduce the hazards.

Make an analysis of the air in different places in the area to determine amount of particulate matter, hydrocarbons, sulfur oxides, and carbon monoxides.

Discuss with agriculture agents and farmers how to reduce the large amount of top soil (30,000 acres) that enters the air each year.

RESOURCES

CONTENT

AIR QUALITY IN SOUTH CAROLINA

What is being done?

1. Industry has and is cleaning up waste.
2. Sanitary landfills are replacing burning dumps.
3. PCA is adopting and enforcing standards and regulations.

WHAT CAN YOU DO?

1. Keep your car in good working condition with pollution control devices intact.
2. Don't burn leaves or trash. Recycle paper and use leaves in compost.
3. Check furnace for proper functioning.
4. Work for good zoning regulations.

STUDENT OBJECTIVES

The student will be able to:

List things being done to maintain good air quality in South Carolina.

Describe things that students and private citizens can do to help maintain good air quality.

Describe ways that private citizens can affect industrial decisions (ex., car emission devices).

Describe ways that private citizens can affect governmental actions.

STUDENT ACTIVITIES

Interview regional planners or do research to find out what is being done now to maintain good air quality in the state and in your area.

Talk to an auto mechanic to find out the values of a tuned car for saving energy and reducing air pollution.

Research to find out what you can do to help maintain good air quality in your neighborhood. Design ways to get this information to others.

Arrange a carpooling program for your school.

Make a list of ways that you can conserve energy and thus lessen pollution.

RESOURCES

REFERENCES

Books and Booklets

American Lung Association. AIR POLLUTION PRIMER. 1974.

American Lung Association. Controlling Air Pollution. A Primer on Stationary Source Control Techniques. 1974.

Battan, Louis J. The Unclean Sky; A Meteorologist's Look at Air Pollution. Garden City, Anchor, 1966.

Blaustein, Elliott H. Anti-Pollution Lab. New York, New York: ARCO Publishing Company, 219 Park Avenue, S., 1975.

Bobrowsky, Kenneth. The Air Above the Ground Below. New York, New York: Science/Search. Scholastic Book Services, 1971.

Holt, Rinehart and Winston. Lab Investigations: Inquiries for Modern Biology, An Introduction to Field Biology. Chamblee, Georgia: Holt, Rinehart, and Winston, 5925 Peachtree Industrial Blvd., 30341, 1973.

Hunter, Donald C., and Henry C. Wohlers. Air Pollution Experiments for Junior and Senior High School Science Classes. Pittsburgh, Pennsylvania: Education Committee Mid-Atlantic States Section, Air Pollution Control Association, 4400 Fifth Avenue, 1968.

Miller, G. Tyler. Living in the Environment: Concepts, Problems, and Alternatives. Belmont, California: Wadsworth Publishing Company, Inc., 94002.

Needed: Clean Air, The Facts About Air Pollution. A Scriptographic Booklet. Greenfield, Massachusetts: Channing Bete Company, 1976.

New York Department of Education. An Environmental Syllabus, Grades 10-12. Bureau of General Education Curriculum Development, Albany, New York 12234.

Pavoni, Joseph L., Hagerty and Heer. Preserving Man's Environment. Louisville, Kentucky: Data Courier Incorporated, 1974, pp. 173-211.

Storin, Diane. Investigating Air, Land, and Water Pollution. Bronxville, New York: Pawnee Publishing Company, Incorporated, One Pondfield Road, 1971.

Pamphlets

A variety of pamphlets may be obtained from the South Carolina Lung Association, 1817 Gadsden Street, Columbia, South Carolina 29201. Telephone number is 765-9066.

American Lung Association, 1740, New York, New York 10019

Clean Air for South Carolina. American Lung Association, Columbia, South Carolina 29201.

Edelson, Edward. The Battle for Clean Air. Public Affairs, Pamphlet Number 403.

How Your State Stands. South Carolina Lung Association, Columbia, South Carolina 29201.

National Wildlife Federation. EQ Index. 1412 16th Street, N.W., Washington, D.C. 20036

United States Environmental Protection Agency. Office of Public Affairs (A107), Washington, D.C. 20450.
Clean Air, The Breath of Life, April 1976. Trends in the Quality of the Nation's Air. March 1977.

Climatic Atlas of the United States.

DHEC-Regulation 62, Air Pollution Control Regulations and Standards. South Carolina Department of Health and Environmental Control. Sims Building, Columbia, South Carolina 29201.

DHEC-1977 Air Pollution Measurements of the South Carolina Air Quality Surveillance Network.

DHEC-South Carolina Air Quality Implementation Plan. 1976.

Eckholm, Erik. Cutting Tobacco's Toll. Washington, D.C.: Worldwatch Papers, Worldwatch Institute, 1776 Massachusetts Avenue, N.W., 20036.

Greer, Ira W., Director. National School Weather Project, State University of New York, Brockport, New York 11442 (no cost).

U. S. Department of Commerce. Climates of the United States. Asheville, North Carolina: Environmental Data Service, National Climatic Center, \$1.85.

Weatherwise. A periodical published bimonthly by Heldref Publications, 4000 Albemarle Street, N.W., Washington, D.C. 20016. Annual subscription is \$10.00.

Worldwatch Paper Series, \$2.00 each, from Worldwatch Institute, 1776 Massachusetts Avenue, N.W., Washington, D.C.

Filmstrips (including pamphlets)

The Economics of the Energy Program

Economics of Pollution

The Economics of the Oceans

From Joint Council on Economics Education, 1212 Avenue of the Americas, New York, New York 10036, or phone (212) 582-5150.

538

537

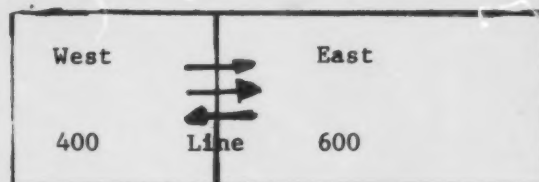
POLLUTION CONTROL PROBLEM

Bad fumes come from an abandoned mine located in the center of a town of 1000 people; 600 people live east of the mine, 400 people to the west of it. The wind blows west to east twice as often as from east to west. Therefore, the damage from the fumes will be twice as great to easterners as to westerners.

Assume the damage in one year to easterners is \$10 per person, and that the damage in one year to westerners is \$5 per person.

All 1000 citizens gather to vote on how much fume control should be provided. Each citizen will have to pay 1/1000th of the costs of control, and a simple majority vote decides how much fume control will be provided.

E = eastern
W = western
B = benefit
C = cost
M = marginal



Does the majority voting mechanism result in an efficient amount of fume control production?

Definition: An economy is said to be efficient if, and only if, there is no way in which goods and services can be re-distributed among consumers, or production tasks reassigned among producers, in such a way that the welfare of at least one individual is increased without decreasing the welfare of some other individual.

Easterners vote to have 51% control, while westerners want only 26%. Since there are more easterners, there will be 51% provided. This is not an efficient amount of fume control since there is room for compromises between the two sides of town that would make everyone better off. In the example, too much fume control is provided.

Per Cent Reduction	Total Cost	Marginal Cost	MB _E	MC _E	Vote _E	MB _W	MC _W	Vote _W
1%	\$ 1	\$ 1	\$0.10	\$0.001	Yes	\$0.05	\$0.001	Yes
2	2	1	0.10	0.001	Yes	0.05	0.001	Yes
3	5	3	0.10	0.003	Yes	0.05	0.003	Yes
4	10	5	0.10	0.005	Yes	0.05	0.005	Yes
25	577	47	0.10	0.047	Yes	0.05	0.047	Yes
26	626	49	0.10	0.049	Yes	0.05	0.049	Yes
27	677	51	0.10	0.051	Yes	0.05	0.051	No
40	1522	77	0.10	0.077	Yes	0.05	0.077	No
41	1601	79	0.10	0.079	Yes	0.05	0.079	No
42	1682	81	0.10	0.081	Yes	0.05	0.081	No
43	1765	83	0.10	0.083	Yes	0.05	0.083	No
49	2305	95	0.10	0.095	Yes	0.05	0.095	No
50	2402	97	0.10	0.097	Yes	0.05	0.097	No
51	2501	99	0.10	0.099	Yes	0.05	0.099	No
52	2602	101	0.10	0.101	No	0.05	0.101	No
99	9650	195	0.10	0.195	No	0.05	0.195	No
100	9802	197	0.10	0.197	No	0.05	0.197	No

DEMONSTRATING A TEMPERATURE INVERSION

Materials needed: 2 tuna size cans
 1 can larger than the above
 2 thermometers (same scale and range)
 1 sheet transparent plastic (13" x 24")
 1 metal cutter
 scotch tape
 1 3/8 " dowel, 30 " long
 wire
 wood block 3/4" to 1" x 6" x 7"
 6 nails
 paper clips
 4 pieces of string at least 2' long
 4 rubber bands
 18 inches of rubber or plastic tubing

Apparatus: Cut the top and the bottom from one tuna can to form a tin ring. Remove the top from the other tuna can but leave the bottom intact. Cut the lid from a larger can which is the same height as the tuna can.

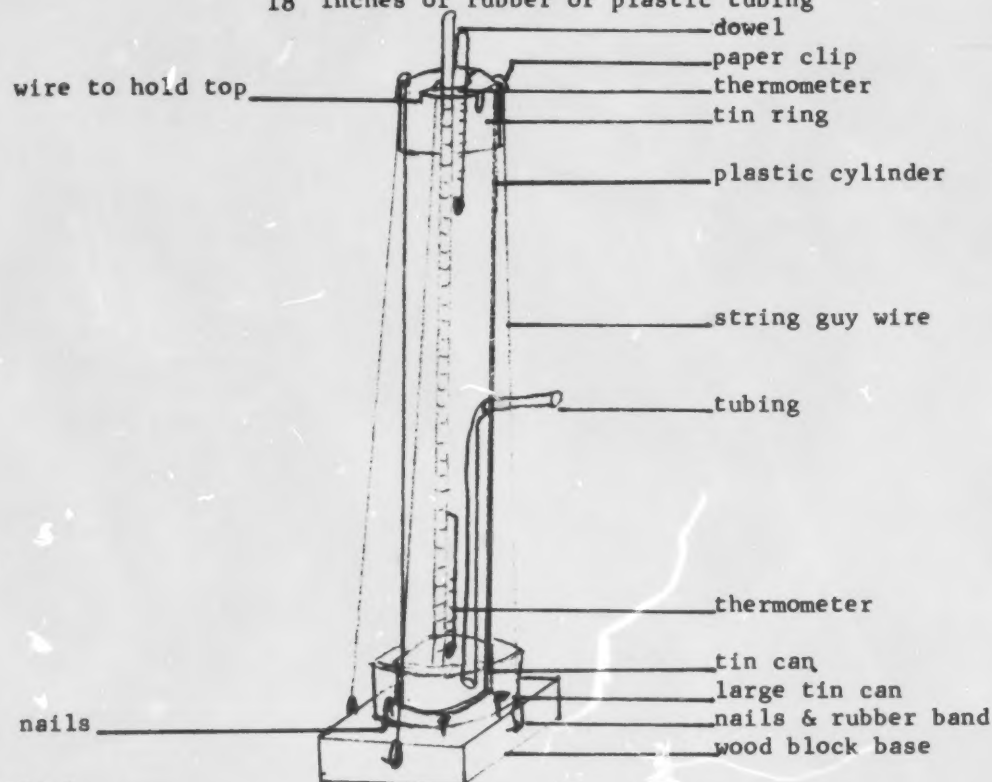
Form a cylinder from the transparent plastic sheet, tape the seam, and attach one end to the inside of the tin ring with paper clips. Using tape, attach the other end to the inside of the tuna can (with bottom).

Punch a hole in the cylinder approximately 10 inches from the bottom. Make the hole the same size as the diameter of the tubing. Push the tubing through the hole so that the end is about one inch from the bottom of the cylinder. Tape the tubing in place so that its entrance into the cylinder is airtight.

Attach two thermometers to the dowel which has been marked in two-inch intervals. The thermometer bulbs should be positioned so that the lower one is two inches from the bottom of the cylinder and the upper one is two inches from the top of the cylinder. Adjust so that the thermometers are easily read.

Place the dowel (with thermometers) in the center of the cylinder and secure with wire looped around the dowel and bent over the cylinder-tin can rim. Loop the wire loosely to allow removal of the dowel and attached thermometers.

Attach the larger can to the wooden base with 4 nails outside and close enough to the can to hold it secure. Drive the remaining 4 nails into the center of each edge of the base. Tie a string to a paper clip at one end and a rubber band to the other. Hook the paper clip over the top of the cylinder and fasten the rubber band to the nail in the base to form guy lines. Repeat for each nail.



PROCEDURE

After assembly of the apparatus, record the reading of each thermometer. Compare the temperatures and explain the differences.

Pour a crushed ice-water mixture between the larger can and cylinder can. Keep the water level below the tape holding the cylinder can onto the plastic cylinder. Read and record thermometers after five minutes.

1. What is the difference in the temperature at the top and at the bottom of the cylinder?
2. If we were to extend the cylinder to the top of the building, would you expect a similar temperature difference? Explain your answer.
3. Explain how similar temperature differences could occur in the atmosphere.

Repeat the above procedure. Introduce smoke by blowing it through the tubing until the cylinder is about one-third full. Describe what happens and explain.

Repeat both activities using hot water instead of cold water.

1. Explain the difference in the behavior of the smoke when over cold and warm air.
2. Would you describe this as a stable or unstable condition?
3. Explain how each of these conditions would affect the dispersal of air pollutants.
4. Describe natural and man-induced atmospheric conditions that could result in similar phenomenon.

LISTING OF SAMPLING SITES AND CODES WITHIN AQCR

053 Augusta - Aiken AQCR

Aiken Eustis Park School
Allendale National Guard Armory
Beech Island Fire Station
North Augusta Police Department
Orangeburg

058 Savannah - Beaufort AQCR

Beaufort County Health Department
Hilton Head at Harbor Town
Savannah (Hardeeville at Looney Luke's)

167 Metropolitan Charlotte AQCR

Bethel Fire Station
Fort Lawn at Metro Chester Water Plant
Lancaster Police Department
Rock Hill Water Treatment Plant
Rock Hill at City Hall

198 Camden - Sumter AQCR

Bishopville at Lee County Agricultural Building
Camden at Kershaw County Health Department
Sumter County Health Department
Sumter Tech
Sumter Water Plant

199 Charleston AQCR

Bushy Park
Charleston County Health Department
Charleston County Hospital
Goose Creek
Harleyville at Jenkins Hill School
James Island Fire Station
Jenkins St. Fire Station
Mt. Pleasant
Meeting Street at Pittsburg Avenue
State Ports Authority

200 Columbia AQCR

Columbia at Eau Claire Water Plant
Columbia at Fort Jackson
Columbia at Richland County Health Department
Columbia at South Carolina Department of Health
and Environmental Control
Columbia at Owens Field
Columbia Sesquicentennial State Park
Columbia Water Plant
Newberry County Education Building
West Columbia Health Center

201 Florence AQCR

Dillon County Health Department
Florence County Health Department

202 Greenville - Spartanburg AQCR

Anderson DSS (County Health Department)
Famoda Farms at Tigerville
Gaffney at Cherokee County Health Department
Greenville Curb Market
Greenville Dog Pound
Greenville at Parker Water and Sewage
Lyman
Norris Manufacturers at Taylors
Pickens County Health Department
Simpsonville at Duke Power
Spartanburg City Hall
Spartanburg at Duke Power
Spartanburg at National Guard Armory
Woodruff
Greer (PW)

203 Greenwood AQCR

Greenwood County Health Department
Laurens County Health Department

Georgetown AQCR
Georgetown at Horry County Health Department
Georgetown (PCA)
Georgetown at Continuous Monitoring Station
Georgetown County Health Department
Georgetown at Howard High School
Myrtle Beach
Georgetown (Maryville)

POPULATION

Populations within an ecosystem are constantly changing in number, composition, and distribution due to the influence of natural and man-made factors. The human population, as part of an ecosystem, has grown so rapidly that many personal, social, and ecological problems have resulted. Efforts to stabilize this population growth in the world have given rise to a number of controversial issues. At present, the rate of population growth has reached the point where people must carefully consider alternatives to maintain the quality of life.

Earth's resources and recycling system can support only a limited number of people. As resources become depleted, freedom for the individual diminishes.

PRE-TEST, POST-TEST

DO YOU KNOW THE FACTS ABOUT POPULATION?
(circle the letter of the best choice)

1. What is the population of the world today?
 - a. 900 million
 - b. 2.2 billion
 - * c. 3.9 billion
 - d. 7.4 billion
 - e. 3.22 billion
2. What is the present rate of growth of world population?
 - a. 1 percent
 - * b. 2 percent
 - c. 5 percent
 - d. 10 percent
 - e. 25 percent
3. If world population continues its present rate of growth, how long will it take to double?
 - a. 10 years or less
 - b. approximately 20 years
 - * c. approximately 35 years
 - d. approximately 85 years
 - e. approximately 120 years
4. What is the population of the United States today?
 - a. under 50 million
 - b. about 75 million
 - c. about 110 million
 - * d. about 210 million
 - e. over 5000 million
5. If the U.S. population continues to grow at its present rate, how long will it take to double?
 - a. 10 years or less
 - b. approximately 20 years
 - c. approximately 35 years
 - * d. approximately 85 years
 - e. approximately 120 years
6. Which of the following countries has the greatest number of people?
 - * a. China
 - b. India
 - c. United States
 - d. Soviet Union
 - e. Brazil
7. Which of the following countries has the fastest growing population in the world today?
 - a. Soviet Union
 - b. United States
 - * c. Mexico
 - d. West Germany
 - e. India
8. In the less developed countries...
 - * a. birth rates are high
 - b. death rates are high
 - c. literacy rates are high
 - d. per capita income is high
 - e. population growth rates are low
9. Which has NOT been a major cause of the population explosion?
 - a. modern preventive medicine
 - * b. increase in birth rates
 - c. improved sanitation
 - d. lower infant mortality
 - e. longer life span
10. What portion of the U.S. population growth is due to immigration?
 - a. 1 percent
 - b. 5 percent
 - c. 12 percent
 - d. 18 percent
 - * e. 25 percent

* DESIGNATES THE ANSWER

CONTENT

Statistical population data provides information and methods for understanding concepts of population changes. A census is a common practice for obtaining population data.

551

STUDENT OBJECTIVES

The student will be able to:

Define and understand the following terms and their relationship to each other: birth, death, immigration, emmigration, growth rate, exponential growth and doubling time, population density, over population, zero population growth, and population per square mile.

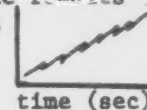
STUDENT ACTIVITIES

Film: Population Ecology
#06806 South Carolina Department of Education

Given an assortment of objects, students will separate them into groups representing different populations and list the major characteristics of each population.

"Whatsits" (doubling time)

- Determine the average number of whatsits (aquarium gravel) in a teaspoonful.
- Populate earth (100 ml beaker or large paper cup) at a rate of one spoonful per 10 seconds until earth is populated.
- Graph the results
whatsits
- Repopulate at rate of one spoonful per six seconds and graph results (x axis in units of six).
- Repopulate at rate of one spoonful per two seconds and graph results (x axis in units of 10, y intervals of two seconds).



RESOURCES

Miller, T. G., p.8.
A Geography Book
Look up terms and put definitions in notebook.

Large beakers or paper cups, assorted rubber stoppers, or package of mixed bird seeds, or mixture of leaves, etc.

One 100 ml beaker or large paper cup.
One 250 ml beaker or larger cup.
100 ml aquarium gravel, plastic teaspoons, and graph paper.

552

CONTENT

The world population is increasing at a very rapid rate.

553

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

- f. Determine doubling times. On which graph is doubling time longer? shorter?
- g. Populate earth again-- for first 20 seconds add whatsits at a rate of one spoonful per 10 seconds, for next 12 seconds at rate of one spoonful per two seconds until reaching 60 ml.
- h. Graph (x axis in units of 10).
- i. Compare this graph with the others.
- j. Using growth curve for world, determine doubling time.

RESOURCES

554

CONTENT

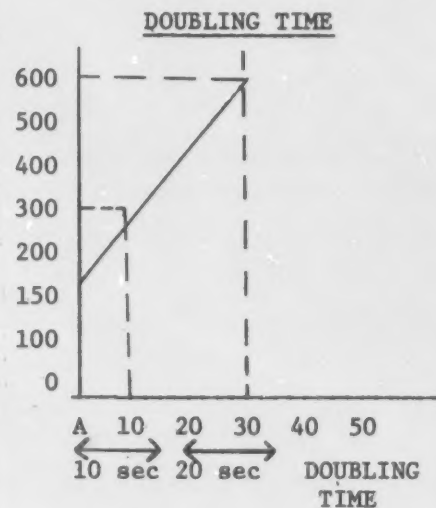
STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

EXAMPLE

Starting population = 150
What's it doubled to 300-,
600-, 1200. Use graph to
determine doubling time.



RESOURCES

CONTENT

The world population is increasing, in part due to medical advances resulting in a decrease in death rate.

557

STUDENT OBJECTIVES

The student will be able to:

Describe the relationship between birth and death rates resulting in an increase in world populations.

Use the data collected by the U.S. Bureau of the Census, including its population analysis studies of composition (by age, sex, race, ethnic groups, employment, education, income and housing) and geographic distribution.

STUDENT ACTIVITIES

Doubling Lily Pads

Suppose you own a pond on which a water lily is growing. The lily plant doubles in size every day. If the lily were allowed to grow unchecked, it would completely cover the pond in 30 days. For a long time the lily plant seems small, and you decide not to worry about cutting it back until it covers half the pond. On what day will that be? (29th day)

Land Area and Population of the U.S. p. 304.

For one week, keep a record of the number of deaths and births in your community. Record your information on a bar graph. (This could be done for a year by contacting the hospital and the coroner.)

RESOURCES

Options: A Study Guide to Population and the American Future, by A. Grant, Population Reference Bureau, Inc., 1973.

558

CONTENT

The world population is increasing at a greater rate in developing lands.

A knowledge of population trends in the U.S. helps people to understand past and present population changes.

559

STUDENT OBJECTIVES

The student will be able to:

Show the relationship between population and development.

Define demography and describe a demographic trend for both human and non-human species.

Identify demographic trends in the history of the U.S. and S.C. and discuss their causes.

Explain how the following factors influence demographic trends: war, famine, disease, agriculture, medical science, industrialization, urbanization, immigration, available resources, social conditioning.

289

STUDENT ACTIVITIES

Choose a developing land (i.e., Latin America, India) and research differences between death rates and birth rates over 20 years. Note change in rate that could be attributed to world health organizations and/or church medical missions.

Compare the population between the U.S. and China. Choose another pair of countries of similar size and compare populations.

View film.

Graph population of S.C. as compared to any two other states in the nation from the year 1900 to 1972 or 1980 and compare the trends in population growths between these three states.

Identify and discuss possible causes for the decline in rate of change at three times in U.S. History.

View film Boomsville.

RESOURCES

Geography and World Affairs, p. 42-43.

World Atlas.

Film: Populations
#07643, S.C. Department
of Education Film Library

U.S. Population Data
Sheet, see page 302 - 303.

Film Boomsville
#00411

560

CONTENT

STUDENT OBJECTIVES

The student will be able to:

Identify and discuss recent changes in U.S. and S.C. population size, composition and distribution.

STUDENT ACTIVITIES

Collect data and graph the growth of S.C. and the U.S. Interpret to the class.

Cemetery Field Trip Data - Discussion

Participants in the 1973 Summer Institute at the University of Cincinnati collected data which illustrates trends in a large, old rather expensive cemetery. Similar data can be gathered in any cemetery. Data should be collected by random sampling, using student data collection forms. Avoid selection on the basis of name, attractiveness of stone, or ease of determining age. Cover as many sections of the cemetery as possible. Calculate age at death and record in time period when death occurred. Figure percentages of deaths in each age category and plot on graph.

RESOURCES

Student Data Form

time periods	totals									
1821 no. 1870 %										
1871 no. 1920 %										
1921 no. 1970 %										
Death	Age at Death	0-5	6-10	11-20	21-30	31-40	41-50	51-60	etc.	over 90

CONTENT

Human and other populations within the earth's ecosystem are constantly changing in numbers, composition and distribution. Factors producing these changes emerge from both natural and man-made systems.

593

STUDENT OBJECTIVES

The student will be able to:

Explain how each of the following natural factors cause population changes in biological ecosystems:

- a. food
- b. climate
- c. disease
- d. interrelationships
- e. natural selection

Analyze the role played by the following factors in population change:

- a. social conditioning
- b. religion
- c. economic development
- d. politics
- e. resources and environment
- f. availability of birth control

291

STUDENT ACTIVITIES

View film: Population Ecology.

Three group reports:

- a. Write a report on the potato famine in Ireland showing population change.
- b. Write a paper on results of monsoon rains as they affect population.
- c. Write a report on black plague and its effect on population.

Other major causes of population changes may be used as a topic. After research is completed, groups will report to class.

Divide the class into groups of three and have each group prepare a class report of one of the following:

"Compare the Family Size of the 1700's to the Family Size of Today."

"Migration to California in 1849 and Shortly Thereafter Due to the Discovery of Gold."

RESOURCES

Film: Population Ecology #12218.

History books, geography books and encyclopedias.

594

CONTENT

Carrying capacity refers to the ability of an area to support a particular number of organisms in a population.

Carrying capacity caused by the interaction of population growth, resources, and technology may be exceeded when pollution is noted.

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

"Displacement of People in the Formation of the Savannah River Project."

"Population Changes due to Industrial Revolution in South Carolina and in Great Britain."

"The Zionist Movement Which Led to the Formation of Israel in 1947."

Interview American citizens of foreign birth and find the political reason for their movement.

Consult the Census Report for an indication of population change due to political activity, generally abroad.

Carrying Capacity

- A. Make an estimate of the carrying capacity of your classroom.
1. How large is the room?
 2. How much space does each person take up?
 3. How much space is taken up by resources, tables, chairs, and desks?
 4. How much open space is needed to have class run smoothly?

RESOURCES

CONTENT

STUDENT OBJECTIVES

The student will be able to:

Explain the term carrying capacity.

Relate carrying capacity to number of cattle that can graze a given area, or wildlife in a given area or people in a given area.

STUDENT ACTIVITIES

Predators and Carrying Capacity

Discuss in small groups and be ready to present your ideas to the other groups: deer vs. wolf population, quail vs. hunting by people, hunting vs. carrying capacity of a population.

Case study:

Imagine you are a rancher with a cattle ranch. On your range, coyotes are eating the rabbits. The Farmer's Organization is discussing offering a bounty for coyotes.

Assume:

Each year, each coyote eats:
125 cottontails
15 jackrabbits
1 calf or lamb

Each year, one cow eats as much grass as:
250 cottontails or 75 jackrabbits

Each year, one sheep eats as much grass as:
50 cottontails or 15 jackrabbits

RESOURCES

CONTENT

There are many conflicting views as to the resolution of the population problem. These often depend on the religious beliefs of the culture, laws and regulations, economic incentives and others.

569

STUDENT OBJECTIVES

The student will be able to:

Examine possible resolutions to problems of increasing population and discuss related issues such as:

- life style changes
- roles of women and equal opportunities
- genetic engineering
- abortion
- positive and negative economic incentives
- sterilization
- family planning

STUDENT ACTIVITIES

Answer these questions:

- How many cows could be fed on the grass that each coyote saves when it eats its years diet of rabbits?
- How many rabbits would 15,000 coyotes eat yearly?
- How many more cattle could you keep as a result of the rabbit loss?
- How many calves or lambs would the coyotes eat each year?
- How many would be left?
- What would happen to your ranch if the coyotes were all poisoned and killed?

Conclude: Are you in favor of establishing coyote control?

Film: Three Young Americans in Search of Survival

Comic book: 300,000,000

Film: Population and the American Future (free loan)

Research and discuss various issues as listed in the objective. What Do You Think?

RESOURCES

Film #08102

570

CONTENT

STUDENT OBJECTIVES

The student will be able to:

- h. economic and social effects of zero population growth on U.S. and world
- i. immigration policies
- j. euthanasia

STUDENT ACTIVITIES

For each statement below, place a check mark in the space which indicates your response. After the administration of this survey, discuss each statement.

RESOURCES

SA - Strongly Agree
A - Agree
N - Neutral
D - Disagree
SD - Strongly Disagree

SA A N D SD

1. The growth of the world population is a serious problem.

2. The growth of the U.S. population is a serious problem.

3. Population growth causes worsening economic and social problems.

4. Population growth is more serious than pollution.

5. U.S. high standard of life may decline because of too many people.

6. Population growth significantly affects energy reserves.

571

295

572

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

RESOURCES

	SA	A	N	D	SD
7. Freedom and individual rights are threatened by overcrowding.					
8. Population distribution is a more serious problem than population growth.					
9. To control population, tax exemption should be provided for only two children.					
10. If underdeveloped countries do not control their population growth, the U.S. should cut off foreign aid.					
11. U.S. should put more money into research for better birth control methods.					
12. U.S. should set up birth control clinics and provide free contraceptives to anyone who requests them.					
13. After two illegitimate births a woman should be sterilized.					

CONTENT

Because of unequal population growth in various parts of the world, serious problems relating to food, resources and standard of living exist.

575

STUDENT OBJECTIVES

The student will be able to:

Describe international problems that result from unequal population growth in various parts of the world.

297

STUDENT ACTIVITIES

Population Density
Arrange the continents of the world.

	Desk	2-person tables
Asia	4	2
Africa	6	3
Europe	4	2
(to USSR)		
Latin America	4	2
North America	4	2
Australia	2	1
Antarctica	2	1

Populate continents. Students on tables simulate continent's population. Each student represents 1/... of the world's population.

SAMPLE

Asia	14 students
Africa	2
Europe	5
Latin America	2
North America	2
Australia	1
Antarctica	0

Discuss food supply, room, natural resources and the differences in behavior of students with enough room from those students who are overcrowded.

RESOURCES

576

CONTENT

Man should understand the implications of population trends and determine alternative plans for the future. People are capable of developing solutions to problems of population change.

577

STUDENT OBJECTIVES

The student will be able to:

Define and discuss future population models such as the MIT study Limits to Growth.

STUDENT ACTIVITIES

Global Simulation Game

Given a bowl of popcorn, a "family" of four will divide the food equally. Increase the family by two members, keeping the amount of food the same. Increase the family again by two. How does this activity relate to the world food supply and overpopulation?

5's Walk on Thursday (Lape)

Watch the film Tragedy of the Commons in four parts. Perform the following activities for each section.

- A. 1. Form a hypothesis about what will happen to our resources (air, water, public lands, parks and schools) when they are used as "commons."
2. Pick a local resource and study it locally. Is it being used wisely?
- B. 1. Discuss overcrowding.
2. List resources which you consider essential for your existence.
- C. 1. List the advantages and disadvantages of large concentrations of people.

RESOURCES

Popcorn

Cassette tape recorder

Film: The Tragedy of the Commons, #12652.

578

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

- D. 1. Investigate and recommend alternatives to overcrowding and heavy use of limited resources.
2. Research current legislation in the U.S. and other countries regarding population incentives and/or controls.

Discuss the question: "Would the world's population have a lesser impact on the environment if urbanization were encouraged or if the population were more widely distributed?"

HOW MANY IS A MILLION?

- a. Measure out one sq. inch of lawn, counting the number of blades in the square. Compare your results with three others and determine an average.
- b. Multiply the average by 144 sq. in., giving the number of blades in a square foot.
- c. Divide the number of blades/square foot into 1 million.

1,000,000

no. of blades/sq. ft. of lawn representing 1 million blades of grass.

RESOURCES

Lawn and ruler

CONTENT

Personal and collective decisions and actions can change the size and nature of populations.

Ex. timing of marriage
fertility planning
attitudes toward
marriage and child-
bearing
government policy
social mores - job
availability, etc.

Increased population affects individuals and society as to: resource demand and depletion
land use
pollution
provision of social services
stability of political systems
health
national economy
expectations and conflicts

STUDENT OBJECTIVES

The student will be able to:

Decide, on the basis of knowledge gained, what his responsibility is toward population control.

Show how population changes affect each of the following in your community and S.C.
housing food
employment urban sprawl
education transportation
loss of open space
economic development
environmental pollution

STUDENT ACTIVITIES

- d. Measure out number of sq. ft. that represent 1 million blades of grass.
- e. If each blade of grass represented one person, how large an area would you need to represent a major city? A town?

Films: Population Explosion, and Man's Impact on the Environment

Research the results of increased populations on the environment.

Using a set income, figure out how much of the income each family member could spend for food, clothing, rent, allowance, etc. How much for a family of six?

RESOURCES

Films: Population Explosion, #07193
Man's Impact on the Environment, #07446

CONTENT

The greater the number of people, the greater the pollution.

More people use more resources faster - resulting in social and political stress.

583

STUDENT OBJECTIVES

The student will be able to:

Experience and express attitudes toward crowded conditions.

Describe effects of increasing population on air and water quality in a city in S.C. or the U.S.

301

STUDENT ACTIVITIES

Crowding

Pretend your classroom is the world (U.S. or State) right now. Spread everyone out in it. Pretend it is the year 2005 and population has doubled. Move everyone to $\frac{1}{2}$ the room. Pretend it is the year 2040 and population doubled again. Move everyone to $\frac{1}{4}$ the room; 2075, $\frac{1}{8}$ th the room; 2110, $\frac{1}{16}$ th the room.

Relate your feelings as you experience overcrowding. Discuss effects of overcrowding on population.

RESOURCES

584

U.S. POPULATION

(population figures in thousands)

	Area (sq. mi.)	Date of admission	First census after admission	1900	1910	1920	1930	1940	1950
United States	3,615,122	—	3,929	76,212	92,228	106,022	123,203	132,165	151,326
Alabama	51,609	1819	128	1,829	2,138	2,348	2,646	2,833	3,062
Alaska	586,412	1959	226	64	64	55	59	73	129
Arizona	113,909	1912	334	123	204	334	436	499	750
Arkansas	53,104	1836	98	1,312	1,574	1,752	1,854	1,849	1,909
California	158,693	1850	93	1,485	2,378	3,427	5,677	6,907	10,586
Colorado	104,247	1876	194	540	799	940	1,036	1,123	1,325
Connecticut	5,009	1788	238	908	1,115	1,381	1,607	1,709	2,007
Delaware	2,057	1787	59	185	202	223	238	267	318
D. of Columbia	67	—	8	279	331	438	487	663	802
Florida	58,560	1845	87	529	753	968	1,468	1,897	2,771
Georgia	58,876	1788	83	2,216	2,609	2,898	2,909	3,124	3,446
Hawaii	6,450	1959	633	154	192	256	368	423	500
Idaho	83,557	1890	89	162	326	432	445	525	589
Illinois	56,400	1818	55	4,822	5,839	6,485	7,631	7,897	8,712
Indiana	36,291	1816	147	2,516	2,701	2,930	3,239	3,428	3,934
Iowa	56,290	1846	192	2,232	2,225	2,404	2,471	2,538	2,621
Kansas	82,264	1861	364	1,470	1,691	1,769	1,881	1,801	1,905
Kentucky	40,395	1792	221	2,147	2,290	2,417	2,615	2,846	2,946
Louisiana	48,523	1812	153	1,382	1,656	1,799	2,102	2,364	2,684
Maine	33,215	1820	298	694	742	749	797	847	914
Maryland	10,577	1788	320	1,188	1,295	1,450	1,632	1,821	2,343
Massachusetts	8,257	1788	379	2,805	3,366	3,852	4,250	4,317	4,572
Michigan	58,216	1837	212	2,241	2,810	3,668	4,842	5,256	5,772
Minnesota	84,068	1858	172	1,751	2,076	2,387	2,564	2,792	2,962
Mississippi	47,716	1817	75	1,551	1,797	1,791	2,010	2,184	2,179
Missouri	69,686	1821	140	3,107	3,293	3,404	3,629	3,785	3,955
Montana	147,138	1889	143	243	376	549	538	559	591
Nebraska	77,227	1867	123	1,066	1,192	1,296	1,378	1,316	1,326
Nevada	110,540	1864	42	42	82	77	91	110	180
New Hampshire	9,304	1788	142	412	431	443	465	492	553
New Jersey	7,836	1787	184	1,884	2,537	3,156	4,041	4,160	4,835
New Mexico	121,666	1912	360	195	327	360	423	532	681
New York	49,576	1788	340	7,269	9,114	10,385	12,588	13,479	14,830
North Carolina	52,586	1789	394	1,894	2,206	2,559	3,170	3,572	4,062
North Dakota	70,665	1889	191	319	577	647	681	642	620
Ohio	41,222	1803	231	4,158	4,767	5,759	6,647	6,908	7,947
Oklahoma	69,919	1907	1,657	790	1,657	2,028	2,396	2,336	2,233
Oregon	96,981	1859	52	414	673	783	954	1,090	1,521
Pennsylvania	45,333	1787	434	6,302	7,665	8,720	9,631	9,900	10,498
Rhode Island	1,214	1790	69	429	543	604	687	713	792
South Carolina	31,055	1788	249	1,340	1,515	1,684	1,739	1,900	2,117
South Dakota	77,047	1889	349	402	584	637	693	643	653
Tennessee	42,244	1796	106	2,021	2,185	2,338	2,617	2,916	3,292
Texas	267,338	1845	213	3,049	3,897	4,663	5,825	6,415	7,711
Utah	84,916	1896	277	277	373	449	508	550	689
Vermont	9,609	1791	154	344	356	352	360	359	378
Virginia	40,817	1788	692	1,854	2,062	2,309	2,422	2,678	3,319
Washington	68,192	1889	357	518	1,142	1,357	1,533	1,736	2,379
West Virginia	24,181	1863	442	959	1,221	1,464	1,729	1,902	2,008
Wisconsin	56,154	1848	305	2,069	2,334	2,632	2,939	3,138	3,435
Wyoming	97,914	1890	63	93	146	194	226	251	291
Puerto Rico ²	3,435	—	—	953	1,118	1,300	1,544	1,869	2,211

Population totals to the nearest thousand.

Data for 1790-1970 from U.S. Bureau of the Census, U.S. Census of Population: 1970, Number of Inhabitants, PC(1)-A1, U.S. Summary (1971). Figures for 1970 population are the latest corrected counts. Provisional birth, death, and infant mortality rates are from U.S. Department of Health, Education, and Welfare, National Center for Health Statistics, *Monthly Vital Statistics Report, Provisional Statistics, Annual Summary*, for the United States, 1971, vol. 20, no. 13 (August 30, 1971).

¹ U.S. population is for 1790, the year of the first national census. District of Columbia data are for 1800; California, Idaho, Maine, Rhode Island, and Wyoming populations are for the years of admission.

² U.S. Department of Commerce, "24 States Show Net Migration Gains During 1960-70, Census Bureau Reports," *News* (May 17, 1971).

DATA SHEET

1960	1970	Percent change, 1960-70	Net migration 1960-70 (percent) ²	Percent urban, 1970 ³	Annual births per 1,000 pop., 1971 ⁴	Annual deaths per 1,000 pop., 1971 ⁴	Infant mortality rate, 1971 ⁴	Population estimates, mid-1972 ⁵	Population projections, 1980 ⁶	
179,323	203,235	13.3	1.7	73.5	17.3	9.3	19.2	208,232	226,934	United States
3,267	3,444	5.4	-7.1	58.4	19.1	9.7	23.6	3,510	3,565	Alabama
226	302	32.8	7.1	48.4	22.9	5.0	18.3	325	352	Alaska
1,302	1,772	36.0	17.5	79.6	21.0	8.6	18.3	1,945	2,164	Arizona
1,786	1,923	7.7	-4.0	50.0	18.1	10.6	19.9	1,978	2,052	Arkansas
15,717	19,953	27.0	13.4	90.9	16.8	8.5	16.8	20,468	24,226	California
1,764	2,207	25.8	12.3	78.5	18.1	8.1	18.0	2,357	2,336	Colorado
2,535	3,032	19.6	8.5	77.4	14.6	8.5	15.5	3,082	3,551	Connecticut
446	548	22.8	8.5	72.2	17.7	6.0	14.4	565	655	Delaware
784	757	-1.0	-13.1	100.0	33.8	13.9	28.5	748	—	D. of Columbia
4,952	6,789	37.1	26.8	80.5	16.5	11.2	20.7	7,259	8,280	Florida
3,943	4,590	16.4	1.3	60.3	20.4	9.0	21.3	4,720	5,191	Georgia
633	770	21.5	1.7	83.1	20.1	5.7	18.1	809	874	Hawaii
667	713	6.8	-6.2	54.1	19.1	8.4	16.6	756	761	Idaho
10,061	11,114	10.2	-0.4	83.0	17.2	9.6	20.7	11,251	12,256	Illinois
4,662	5,194	11.4	-0.3	64.9	18.3	9.3	18.0	5,291	5,782	Indiana
2,758	2,825	2.4	-6.6	57.2	16.1	10.3	17.0	2,883	2,908	Iowa
2,179	2,249	3.1	-6.0	66.1	15.1	9.6	19.8	2,258	2,334	Kansas
3,036	3,219	5.9	-5.0	52.3	18.1	10.3	20.4	3,299	3,372	Kentucky
3,257	3,643	11.8	-4.0	66.1	20.1	9.2	22.1	3,720	3,975	Louisiana
969	994	2.4	-7.2	50.8	17.3	10.7	16.3	1,029	1,016	Maine
3,101	3,922	26.5	12.4	76.6	14.3	7.9	18.0	4,056	4,782	Maryland
5,141	5,669	10.5	1.4	84.6	15.7	9.9	17.1	5,787	6,277	Massachusetts
7,823	8,875	13.4	0.3	73.8	17.9	8.5	19.2	9,082	10,031	Michigan
3,414	3,805	11.5	-0.7	66.4	16.3	8.9	17.8	3,896	4,245	Minnesota
2,178	2,217	1.8	-12.3	44.5	21.7	10.4	26.6	2,263*	2,245	Mississippi
4,320	4,677	8.3	—	70.1	17.1	10.9	19.0	4,753	5,070	Missouri
675	694	2.9	-8.6	53.4	17.2	9.5	20.7	719	721	Montana
1,411	1,484	5.1	-5.2	61.5	17.0	10.2	17.2	1,525	1,570	Nebraska
265	489	71.3	50.4	80.9	18.9	8.3	22.9	527	673	Nevada
607	738	21.5	11.3	56.4	16.6	9.8	15.6	771	878	New Hampshire
6,067	7,168	18.2	8.0	88.9	15.1	9.2	18.0	7,367	8,300	New Jersey
951	1,016	6.8	-13.6	69.8	21.6	7.5	20.9	1,065	1,088	New Mexico
16,762	18,241	8.7	-0.6	85.6	15.5	10.1	18.6	18,366	19,789	New York
4,556	5,082	11.5	-2.1	45.0	18.6	8.8	22.2	5,214	5,482	North Carolina
632	618	-2.3	-14.9	44.3	17.5	9.2	15.3	632	600	North Dakota
9,706	10,652	9.7	-1.3	75.3	17.7	9.2	18.2	10,783	11,675	Ohio
2,326	2,559	9.9	0.6	68.0	17.2	9.6	18.4	2,634	2,787	Oklahoma
1,769	2,091	18.2	9.0	67.1	15.8	9.3	18.1	2,182	2,421	Oregon
11,319	11,794	4.2	-3.3	71.5	15.2	10.5	18.1	11,926	12,157	Pennsylvania
859	950	10.1	1.5	87.1	15.8	9.8	18.9	968	1,027	Rhode Island
2,383	2,591	8.7	-6.3	47.6	20.2	8.8	22.5	2,665	2,731	South Carolina
661	666	-2.2	-13.9	44.6	17.0	9.9	17.1	679	658	South Dakota
3,567	3,924	10.0	-1.3	58.8	19.1	10.0	21.6	4,031	4,259	Tennessee
9,580	11,197	16.9	1.5	79.7	20.1	8.1	19.5	11,649	12,812	Texas
891	1,059	18.9	-1.2	80.4	25.8	6.8	14.1	1,126	1,234	Utah
390	445	14.0	3.8	32.2	17.1	9.7	15.0	462	504	Vermont
3,967	4,648	17.2	3.6	63.1	16.9	8.2	20.8	4,764	5,229	Virginia
2,853	3,409	19.5	8.7	72.6	15.7	8.8	18.6	3,443	3,958	Washington
1,860	1,744	-6.2	-14.2	39.0	18.0	11.5	21.9	1,781	1,634	West Virginia
3,952	4,418	11.8	0.1	65.9	16.0	9.1	15.7	4,520	4,930	Wisconsin
330	332	0.7	-11.9	60.5	17.4	8.9	21.1	345	342	Wyoming
2,350	2,710	15.4	—	58.1	25.4	6.5	24.5	—	—	Puerto Rico

303

U.S. Bureau of the Census, U.S. Census of Population: 1970, Number of Inhabitants, PC(1)-A1, U.S. Summary (1971).
² Deaths to infants under one year of age per 1,000 live births.
³ July 1, 1972 population estimates from U.S. Bureau of the Census.
⁴ Estimates of the Population of States: July 1, 1971 and 1972.
⁵ Current Population Reports, Series P-25, No. 488 (September 1972).

* Population projections (Series 1-E) for 1980 from U.S. Bureau of the Census, "Preliminary Projections of the Population of States: 1975-1990," Current Population Reports, Series P-25, No. 477 (March 1972).
⁶ Population given for 1960 is the 1899 figure; birth and death rates are for 1970.

LAND AREA AND POPULATION OF THE UNITED STATES*

Year	Density per square mile	Land area of the United States (square miles)	Rate of change per year	Population of the United States
1790	4.5	864,746	-	3,929,214
1800	6.1	864,746	+ .16	5,308,483
1810	4.3	1,681,828	- .18	7,239,881
1820	5.5	1,749,462	+ .12	9,638,453
1830	7.4	1,749,462	+ .19	12,866,020
1840	9.8	1,749,462	+ .24	17,069,453
1850	7.9	2,940,042	- .21	23,191,876
1860	10.6	2,969,640	+ .27	31,443,321
1870	13.4	2,969,640	+ .28	39,818,449
1880	16.9	2,969,640	+ .35	50,155,783
1890	21.2	2,969,640	+ .43	62,947,714
1900	25.6	2,969,834	+ .44	75,994,575
1910	31.0	2,969,565	+ .54	91,972,266
1920	35.6	2,969,451	+ .46	105,710,620
1930	41.2	2,977,128	+ .56	122,775,046
1940	44.2	2,977,128	+ .32	131,669,275
1950	42.6	3,552,206	- .16	151,325,798
1960	50.6	3,540,911	+ .80	179,323,175
1970	57.1	3,536,855	+ .65	203,211,926

Using the data for the human population and land area of the United States since 1790, compute the population density per square mile for each decade. Also compute the rate of change in the human population in the United States every decade. Then construct a graph showing:

- the population of the U.S. from 1790 to 1970
- the population density from 1790 to 1970
- the rate of change at ten-year intervals

Formulating Generalizations

- Which of the three lines could you extend with reasonable accuracy to the year 2050? Explain. (the graph showing the population of the U.S. because it shows a steady increase)
- How would the line showing the population of the U.S. compare with a graph of a hypothetical bacteria population? (they would be very similar - exponential)
- From the population trend, which is higher, natality rate or mortality rate?
- What other factors could cause the human population to increase? (a decrease in physiological disorders, better health standards, immigration)
- How are the three lines different? How are they similar? Why are there differences in the lines? (population density and population are nearly the same because as the population size increases, the density should also rise proportionately, assuming the area is the same or nearly so)
- How do you account for a decrease in land area in 1950 and 1960? (land area of the U.S. has been covered by the reservoirs of dams built to supply water and power)

* The World Almanac and Book of Facts. 1975 Edition. Newspaper Enterprise Association, Inc., New York, 1974. + increase
- decrease

REFERENCES

Two Major References for the Teacher

- Miller, G. Tyler, Jr. Living in the Environment, Concepts, Problems, and Alternatives. Wadsworth Publishing, Company, Belmont, California. 1975.
- Schultz, Judith M. and Herbert L. Coon. Population Education Activities for the Classroom. ERIC/SMEAC. Ohio State University, Columbus, Ohio 43212. 1977.

Others

- Ehrlich, Paul R. The Population Bomb. New York: Ballantine, 1968.
- "Equilibrium," Zero Population Growth, 4080 Fabian Way, Palo Alto, CA 94303, January 1974.
- Horsley, Kathryn, et. al. Environment and Population: A Source Book for Teachers. Washington: Population Reference Bureau, 1755 Massachusetts Ave., NE, Washington, DC 20036.
- Interchange (Monthly). Washington: Population Reference Bureau.
- Kohlsaat, Tom. "Which Way Carolina?" South Carolina Wildlife. Columbia, SC. Wildlife and Marine Resources Department, Nov-Dec 1975.
- Meadows, Donella H., et. al. The Limits to Growth. New York: Universe Books, 1972.
- National Association for Environmental Education. Man and Environment for Secondary Schools. Miami: NAEE, 5940 S.W. 73 St., Florida 33143.
- Planet Management Game. Boston: Houghton Mifflin.
- Population and the American Future. New York: New American Library, 1972.
- Sauer, Rab, ed. Voyages: Scenarios for a Ship Called Earth. New York: Ballentine, 1971.
- Schultz, Judith M., and Herbert L. Coon. Population Education Activities for the Classroom. Columbus, Ohio: ERIC Center for Science, Mathematics, and Environmental Education, The Ohio State University, 1977, p. 183.

REFERENCES CON'T.

"Three Hundred Million." Comic from Public Information Branch, International Labor Office, 666 11th St., NW, Washington, DC 20001.

"Taking Honor." Scholastic Scope, May 17, 1971.

Activity Cards

Population Activity Cards. Environmental Education Office, Washington State Department of Education, Olympia, Washington.

FILMS

Films from the Audio-Visual Library, S.C. Department of Education:

Boomaville #00411

Man's Impact on the Environment #07446

Populations #07643

Population Ecology #06806 and 12218

Population Explosion #07193

The Tragedy of the Commons #12652

Three Young Americans in Search of Survival #08102

Films from Population Affairs Film Collection, National Audio-Visual Collection, Washington, DC 20409:

ex. Population and the American Future

Tape:

"Fives Walk on Thursday" Science Workshop, Inc., Box 9785, Atlanta, GA 30319.

Other Sources of Population Information:

Bureau of Census, Public Information Office, Department of Commerce, Washington, DC 20233

Center for Population Research, National Institute of Health, Bethesda, MD 20014

Office of Population Affairs, Department of Health, Education and Welfare, Washington, DC 20201

Planned Parenthood, World Population, 810 7th Ave., New York, NY 10019

Population Institute, 100 Maryland Ave., NE, Washington, DC 20002

Worldwatch Paper Series, \$2.00 each, from Worldwatch Institute, 1776 Massachusetts Ave., NW, Washington, DC 20036.

- a. Newland, Kathleen. Women and Population Growth: Choice Beyond Childbearing. 1977.
- b. Stokes, Bruce. Filling the Family Planning Gap. 1977.
- c. Brown, Lester R., et. al. Twenty-Two Dimensions of the Population Problem. 1976.
- d. Brown, Lester R. World Population Trends: Signs of Hope, Signs of Stress. 1976.
- e. Eckholm, Erik and Kathleen Newland. Health: The Family Planning Factor. 1977.

"PUT SOMETHING WILD IN YOUR LIFE - SOUTH CAROLINA WILDLIFE"

The term wildlife has been defined as all animals whose needs for survival are supplied under natural conditions. Some feel that it should not be limited to animals but should include all living things. For this unit the first definition will be used. Wildlife are a valuable resource. Wildlife serve as pollinators of flowers, provide food and fiber, clean the environment, serve as a source of recreation and as an inspiration for song, art, literature, and dance. Wildlife have also been used as indicators of pollution and presence of high levels of toxic substances.

Wildlife are adapted to particular habitats. Once the habitat has been modified or destroyed, wildlife may adapt, decrease in numbers, move to a more favorable habitat or even become extinct. Once a species becomes extinct, it cannot be recreated and is lost forever. Conservation of wildlife must include conservation of habitat and must consider human activities which affect the habitat. Adverse climatic changes, population growth and increased technology in all parts of the world are threatening wildlife. Wildlife management or habitat management should be a concern of every citizen.

In order to manage wildlife habitat we must understand the interrelationships between species, between species and their environments, and between species and man. Wise management does not mean fenced in areas, zoos, etc., to preserve a few. It may mean preservation of hedgerows, wooded buffer areas around apartment complexes and in developments; it may mean siltation and sediment legislation and enforcement to maintain clean water habitats; it may mean hunting to regulate population so that overgrazing and habitat destruction does not occur; it may mean setting up bird nesting boxes and identifying areas that need to be restricted from human activities. The South Carolina Wildlife and Marine Resources Department is concerned with wise

management of wildlife and enforcement of State laws that pertain to wildlife. There are also federal agencies concerned with preservation and management of wildlife.

Identified as one of the fastest growing areas in the nation, South Carolina is seeing new industry, new housing developments, marshlands dredged and changed to housing areas, increased use of agricultural land and reduction of hedge rows and a major increase in population. As humans increase in number and in their demands on the land, there is less habitat for wildlife. There is still an abundance of good habitat in South Carolina. It is our choice - how we grow and develop is still a decision that we can make. The responsibility is ours.

CONTENT

The best way to study wildlife is through observation in the out-of-doors.

599

STUDENT OBJECTIVE

The student will be able to:

Observe and record the different kinds of animals living in a given environment.

311

STUDENT ACTIVITIES

Make an insect collection of insects in your own area. Note where they were found and what they were doing (flying, eating a plant, etc.)

Make a study of aquatic animals. Using nets, bottles, etc., collect and examine and identify as many water animals as possible. Don't forget to look on leaves and under rocks. Record your findings.

Take a "hunting" trip through the area with the intention of capturing various "game" on film. After the hunting trip describe your feelings as you zoomed in for the "kill".

RESOURCES

Insect trap and killing jar. Using small strips of cloth 8 X 25 mm coated with syrup, tack to trees, etc.,

Insect net.

Aquatic animal trap. Using nylon hose, bottles or jars create a trap for water animals.

Children's own cameras.

600

CONTENT

STUDENT OBJECTIVE

The student will be able to:

Conduct a survey of wildlife in a given area to include:

Evidence - nests, foot prints, etc.

Live trapping for study and tagging.

Basic information about the habitat where the animal is found.

Population sampling techniques.

STUDENT ACTIVITIES

Conduct a simplified Environmental Impact Study. Find an area in the community where some type of construction is planned. Perform a survey to determine the organisms in the area. After compiling the survey results, study the plans for construction and make a prediction of the impact on the organisms found. Write these statements on a poster. Continue to survey the area during construction and after construction. Evaluate the original statements on the poster.

How were the statements correct?
How were some things different?

Do a field study to identify and record the different animals found in the school yard or your yard at home.

Do the same study after 2 weeks to determine changes in the animal population. If changes are noted, describe them and list possible reasons for the changes.

RESOURCES

CONTENT

STUDENT OBJECTIVE

The student will be able to:

STUDENT ACTIVITIES

Make plaster of paris casts of animal tracks that you find and identify the tracks, noting where they were found. Measure from one track to the next in the field and from one foot to the next print of the same foot. Determine if the animal was walking or running.

Choose a single species of animal that lives in your neighborhood and write a paragraph describing its life history. In small groups make a survey of animals in a designated area. Use survey form illustrated below. After groups have completed their surveys, compile results on blackboard. Discuss the animal populations of the areas studied. After one month or more reconduct the survey and determine any changes.

RESOURCES

See p. 338-339.

Identification books from library.

Wildlife Tracks

S. C. Wildlife Resources

CONTENT

STUDENT OBJECTIVE

The student will be able to:

Recognize different animals by sound.

Describe the type of shelter desired by certain species.

STUDENT ACTIVITIES

SURVEY FORM

Name of surveyor _____

Location of survey _____

Type of animal	Location Number

Comments (Time, what doing, what eating, etc.)

Play recordings of animal sounds, ex. birds, frogs, etc. and see if the class can identify the individual.

Build different bird nesting boxes, ex. bluebird, wood duck, other. Display your boxes and explain the reasons for the specifications of each.

Make a bird calendar. Indicate date and time seen and location. Note if it is a migratory bird, a seasonal bird, or one that is in the area all year.

RESOURCES

Records
Available from the National Wildlife Federation or check with S. C. Federation.

Building materials and specifications from the Wildlife and Marine Resources Dept.

Bird keys.

CONTENT

STUDENT OBJECTIVES

STUDENT ACTIVITIES

RESOURCES

The student will be able to:

Describe distinguishing characteristics of local wildlife.

The teacher and students develop a list on the chalkboard of animals (fish, snails, birds, snakes, frogs, whatever) of at least five more than the total number of class members. Each name is placed on a piece of paper or small card and all are placed in a container. Each student draws a card and picks the organism for the purpose of the game. Students have three days to research the characteristics of their animals. They list these characteristics from the most general to the most specific. When the students turn to report on the chosen animal comes, the student reads from his list one characteristic at a time to the class with additions until identified and added to the classroom poster.

A natural and interacting group of populations of species of plants and animals living together in a particular environment is known as a community.

There are many kinds of communities - ex. woodland, grassland, aquatic, etc.

Describe several different kinds of community.

Take a field trip to visit several different kinds of communities and describe the differences and similarities.

Tour the school ground and determine the type of natural community there.

Biology Text - Green BSCS
Soil Conservation slides.

CONTENT

In a wooded area trees, squirrels, insects, toads and many other animals and plants find what they need for existence.

Animals have developed adaptive characteristics for different environments.

STUDENT OBJECTIVES

The student will be able to:

Define what is meant by community in nature.

Make a study of a community including:

Kinds of plants in greatest abundance - climax plants.

Physical factors such as temperature, humidity, soil type and conditions, light intensity.

Kinds of animals associated with the plants noted and with each other.

Diagram a food web existing in one of the communities examined.

Identify adaptive features of different animals.

STUDENT ACTIVITIES

Discuss the meaning of the term community and compare it to a human community.

Choose one community to study. Make a list of the plants and animals there and note "who eats whom" and what is used for shelter.

Draw a food web including all organisms in your community. Describe your community as you think it was 50 years ago and will be 50 years from now.

Using pictures of animals show examples of protective coloration. Make a list of other protective animal adaptations.

RESOURCES

S. C. Wildlife and Marine Resources films

CONTENT

Habitat includes those environmental conditions essential to the survival of a population of animals. It includes water, food, cover or shelter and range (territory).

South Carolina is blessed with many different habitats and a wide diversity and abundance of wildlife.

611

STUDENT OBJECTIVES

The student will be able to:

Describe the habitats of 5 species of wildlife common to South Carolina.

Identify suitable wildlife habitats on the school ground.

317

STUDENT ACTIVITIES

Using the beak and feet chart identify the kinds of food eaten by birds with each type of beak; identify the kinds of places one would expect to find birds with each type of feet.

Make a collage showing adaptations of animals (ex. for water life or for running and stalking in the grasses, etc.) Consider adaptation of native and introduced species.

Choose a common animal of South Carolina, ex. white tail deer, Carolina wren, etc., and describe the habitat that they require to survive. Include all aspects of habitat - water, food, shelter, cover, territory.

Tour your school ground and see if you can find an area of suitable habitat for wildlife (at least one species). If that species does not already inhabit the area explain possible reasons.

Suggest ways for improving habitat on the school ground for particular species which you may wish to attract.

RESOURCES

S. C. Wildlife and Marine Resources Dept. (p. 318)

S. C. Wildlife and Marine Resources chart of S. C. wildlife representatives

612

HOW IS YOUR I.Q. ON BIRDS FEET?
by William D. Rodgers, Jr.



HUMMING BIRD



PERCHING BIRD



RAIL



PHEASANT



GROUSE



HERON



EAGLE



GANNET



WOODPECKER



GREBE



DUCK



DUCK HAWK

The South Carolina Wildlife
Resources Department,
James W. Webb, Executive
Director, P. O. Box 167,
Columbia, SC 29202

CONTENT

Cover may be shelter from the weather, cover for stalking, breeding or bedding.

615

STUDENT OBJECTIVES

The student will be able to:

Identify regions of S. C. and/or local areas which differ in types of vegetation and thus provide different habitats.

Identify animals that could be described as urban, rural, or suburban.

319

STUDENT ACTIVITIES

Using maps of S. C. describe and compare the different ecosystems in different S. C. geographic areas - ex. coastal plains, sand hills, piedmont, mountains. List several animals that you would expect to find in each one but not in all of them.

Paste pictures of different habitats on a poster. Cut out small pictures of animals that live in the habitats and see if you or your friend can place each animal in the proper habitat.

Take a field trip or trips to the coast, midlands, mountains, etc., to compare habitats and differences in animals found in each area. (Don't forget altitude, average rainfall, average temperature, etc.)

Find a rural, urban and suburban animal and list evidence to support your claim for its habitat.

RESOURCES

Maps from the S. C. Land Resources Department

Background reference pp. 340-345.

616

CONTENT

Most animal species require a particular amount of space or territory. Ex. - The bluebird needs a few hundred square feet, a deer may range for miles.

Food, water and shelter must be arranged appropriately for a given species. If food or water is too far from shelter or cover the habitat is not suitable for survival.

Every habitat has a specific carrying capacity. The carrying capacity can vary from day to day, season to season with particular limitations at any given time.

STUDENT OBJECTIVES

The student will be able to:

Show that different animal species require different sizes of territory.

Describe the importance of location of essential factors in the habitat to survival.

Define carrying capacity and list factors that affect it.

STUDENT ACTIVITIES

Using the library, choose four animals and describe the size of range or territory required by each.

Construct and set up feeding stations and determine the territory of the birds that come to the station.

Hang a clothes line high between 2 poles. See which birds come to the lines, try to follow one of the birds to determine its trail or territory.

Choose one animal and draw a map of its territory indicating the optimal distance between food, water and cover and outer edges of its territory.

Conduct a population analysis of an organism in the school yard and determine those things that affect the carrying capacity.

RESOURCES

CONTENT

Given sufficient natural resources a population will continue to increase in size until some limiting factor is imposed - ex. disease, food, predators.

Living things tend to produce more of their kind than their habitat can support.

The depletion of a population of any one species is usually due to changes in habitat rather than by hunting, poaching or trapping.

STUDENT OBJECTIVES

The student will be able to:

List the predators or other factors that keep a population in check.

Explain the role of hunting in wildlife management.

STUDENT ACTIVITIES

Conduct a survey of desirable or welcome inhabitants (ex. birds, mantids, toads, etc.).

Conduct a survey of undesirables (ex. slugs, mice, roaches, etc.). Describe how you determine the desirability of animals in your yard.

Check the library and local wildlife conservationist and write a report on factors that control the white deer population in S. C. (or the beavers or others).

Write a report on the role of hunting in population control. Include:

What % of deer are harvested each year?

How are bag limits established?

What % of migrating fowl are hunted each year?

Does hunting endanger the wildlife resource?

RESOURCES

CONTENT

Wildlife species are interdependent with one another and with their environment.

Some species are vulnerable to depletion in quantity and quality of food. These species usually have specific food needs. Ex. fish-eating birds do not reproduce if the fish die of polluted water or contain large amounts of pesticide. Other species are very adaptable - ex. starlings, sparrows, etc.

Some species compete with other species for the same food source.

The addition or removal of a species from a community may have harmful or beneficial consequences.

Introduced species can become pests due to lack of natural enemies.

STUDENT OBJECTIVES

The student will be able to:

Describe interdependences among living things in their region of S. C. and on the school ground.

Identify alien animals who have been imported and their country of origin and their impact on the ecosystem.

STUDENT ACTIVITIES

Food Web Game

Make cards in sufficient quantity so that each student has a card. Put the name of a plant or an animal, the sun, soil, etc., on each one. Then let each student pick a card from the pack and sit in a large circle. Using a LARGE ball of string have student connect to student who is interdependent for food or shelter or something vital to survival. The result should be a tremendous tangled web - an example of the interdependencies of all living things. Be sure to include humans on one of the cards.

Once all students are connected CUT THE STRING IN ONE SPOT. How many are affected by the removal of this one species from the community?

Report on species introduced to S. C. from other countries and explain how each has adapted to the habitats here.

RESOURCES

G. T. Miller P. 167

CONTENT

STUDENT OBJECTIVES

STUDENT ACTIVITIES

RESOURCES

The student will be able to:

Debate: A new canal in Central America connecting the Atlantic and Pacific - consider the changes in animal life that could result.

View ITV movie - Should Oceans Meet.

Debate: Pros and cons of introduction of new species into the country, ex. ring-necked pheasant, English sparrow, water hyacinth, grass carp, etc.

Visit two ponds. One with erosion resulting in siltation in the pond; the other with grassy banks and clear water. Using a seining net, find out which pond contains the most fish.

Report on the introduction of the red wolves to Bull's Island of Cape Romain Wildlife Refuge.

Any one of an environment's components may become a limiting factor. Ex. food, water, air, space, cover.

Wildlife resources may be limited in quality, quantity and distribution.

Habitat diversity promotes wildlife. The diversity and quality of wildlife populations may be a barometer for quality of life for all species.

Identify the limiting factors for a selected species in a specified area.

Describe management techniques useful for maintenance of diversity of habitat and promotion of viable populations.

CONTENT

Changes in habitat can cause species to become endangered or extinct. Humans change the habitat in a variety of ways. Human activities are related to wildlife survival.

Where have all the eagles gone? Man's land use practices have had an adverse affect on the existence of certain plants and animals. Many species across the state and nation have come close to extinction and some have become extinct.

Endangered - A species whose population is naturally low or whose numbers have been reduced throughout all or a significant portion of its range.

STUDENT OBJECTIVES

The student will be able to:

Name 10 endangered species in S. C. and describe factors that contributed to their endangered status.

Describe the habitats of 5 endangered animal species in your region of S. C.

Distinguish between rare, endangered, peripheral, status unknown, and extinct.

Name 5 extinct species that once inhabited S. C.

STUDENT ACTIVITIES

Obtain a list of endangered S. C. species from the S. C. Wildlife and Marine Resources Dept. and look up information that will indicate the causes of their endangered status.

Pick one endangered species in your part of S. C. and find out what kind of habitat is necessary for its survival. Share your information with the class. How could you and your class help it survive?

Complete the endangered animal find-a-word puzzle and then discuss: What type of animals (birds, mammals, etc.) are most endangered? What are the possible reasons? Is there a historical reason? Other than whales, what group is most endangered? Explain possible reasons.

RESOURCES

S. C. Wildlife, Endangered Species of S. C. Past, Present and Future (a S. C. newsletter, from the S. C. Museum Commission).

Newsletters from the S. C. Museum Commission

Puzzle p. 325.

FIND THE ENDANGERED ANIMAL

Located in the following puzzle are the names or parts of the names of many of the animals that are considered endangered species in the state of South Carolina. The names you are looking for may be written horizontally, vertically, diagonally, backwards, or forwards. They are written in a straight line so that no name will be found written around a corner. The list beside the puzzle includes the full common name of the animal and the part underlined is the part that is located in the puzzle.

H A S N A M H C A B R
 R U T H G I R N E G E
 O B M C D Y R O V I K
 T A B P E L I C A N C
 A E U L B R F L H R E
 G Y E E T A N A M E P
 I E S E I G C F R N D
 L L O R D U I K E P O
 L D N T L O J B P O O
 A I K B A C K O S G W
 L R E L B R A W G I Z

Endangered species list for the state:

BIRDS

PEREGRINE FALCON
 BACHMAN'S WARBLER
 BROWN PELICAN
 IVORY-BILLED WOODPECKER
 KIRTLAND'S WARBLER
 RED-COCKADED WOODPECKER
 SOUTHERN BALD EAGLE

REPTILES

LOGGERHEAD TURTLE
 ATLANTIC LEATHERBACK TURTLE
 ATLANTIC RIDLEY TURTLE
 GOPHER TORTOISE
 PINE BARRENS TREE FROG
ZIGZAG SALAMANDER

MAMMALS

ATLANTIC RIGHT WHALE
 BLUE WHALE
 BOWHEAD WHALE
 EASTERN COUGAR
 FINBACK WHALE
 FLORIDA MANATEE
 HUMPBAC WHALE
 INDIANA BAT
 SEI WHALE
 SPERM WHALE

FISH

SHORTNOSE STURGEON

CONTENT

Threatened - A species not endangered yet whose population has been reduced at an alarming rate.

Peripheral - A species with sufficient numbers but have been common in areas on the periphery of its normal range. Usually indicates the species has been moved out of its normal habitat through destruction of the habitat or the introduction of another organism which has predomination over the normal habitat.

Status Unknown - This indicates a lack of information as to the population or condition of the species.

Rare - A species whose requirements for existence force it to very limited areas.

History indicates that if a species has high economic value, moves across international boundaries (therefore not protected by national law), has low reproductive rate, does not adapt readily to man, has a negative image (ex. grizzly bear), and depends on single or very limited food source he is apt to become endangered.

639

STUDENT OBJECTIVES

The student will be able to:

Differentiate between certain status classifications of species population.

Identify characteristics and conditions that contribute to a species becoming endangered.

STUDENT ACTIVITIES

Make a list of state species--be sure to include some examples for each status classification. Label each.

Working in small groups or individually, select an animal from the list of endangered species and find the following information:

1. where animal is normally found
2. existence in S. C.
3. reasons for the animal to be considered endangered
4. past and present range
5. population data over a period of time
6. length of time on endangered list
7. efforts to assist this species
8. agencies and organizations working on the problem
9. things you and your class could do to help
10. why you think this species should survive

RESOURCES

"Toward Extinction" by Ken Stansell, S. C. Wildlife

"DDT Kills Eagles, Does it Kill Humans?" Sci. Am.

630

CONTENT

Each species has a critical population size, below which it cannot survive.

Any increase or decrease in numbers of one organism can have serious effects on the others sharing the habitat area.

Some species cannot adapt to man-made environmental changes.

631

STUDENT OBJECTIVES

The student will be able to:

Identify the major causes of extinction (ex. change in habitat, direct killing or poisoning, indirect - pollution, introduction of alien competitors or predators).

Explain the effect of depletion of one species on others living in the area.

Differentiate between natural and man-induced environmental change and the influence of both on species rate of change.

STUDENT ACTIVITIES

Debate: Pros and cons of using insecticides on crops... as they affect wildlife and our food supply and cost.

Describe the impact on the hawk population if there is an increase in the mice population. Give other examples of impact of increased or decreased numbers of a population.

Discuss the deer population in S. C. and its impact on other species. What and when should man kill? How do changes in animal species population numbers affect you as a member of the biotic community?

Identify species that have decreased in population due to man-induced environmental change and some that have decreased due to natural changes. Explain the changes and impact on the species.

RESOURCES

S. C. Wildlife

CONTENT

Wildlife should be protected from extinction because of their value in the ecosystem and aesthetic, recreation and economic value to man. One aim of wildlife management is to prevent extinction.

People need wildlife:

Insects to pollinate flowers
Earthworms to aerate the soil
Birds to scatter seeds and eat insects
Snakes to control rodent populations
Buzzards and others clean up by eating dead animals
Recreation - hunting and fishing, etc.

STUDENT OBJECTIVES

The student will be able to:

Identify areas of the U.S. where animals have become extinct.

Describe some of the considerations involved in management to prevent extinction.

List ways that people benefit from wildlife.

STUDENT ACTIVITIES

Using copies of a U.S. map, locate the areas of extinct animals. Find possible causes and discuss why extinction occurred in these patterns.

Discuss: Who cares and why? -- that the passenger pigeon is extinct and other animals like the bald eagle nearly extinct.

View the film Say Goodby and discuss the problems illustrated. Identify the biases in the film. List specific recommendations that could be sent to proper agencies.

By interviews and/or library research try to find as many as possible different ways that you personally benefit from wildlife. Identify the various species responsible for each benefit.

Write a story about a fishing or hunting trip that you have taken. Include what you learned about habitat.

RESOURCES

Say Goodby, a film from the S. C. A-V Library.

CONTENT

Because habitats of many species are being destroyed and the public demand for enjoyment of animals is not compatible to an urban environment, communities are being encouraged to create controlled environments or zoos.

635

STUDENT OBJECTIVES

The student will be able to:

Describe the values of zoos. Identify some of the problems involved in constructing a controlled environment or zoo.

329

STUDENT ACTIVITIES

Find out the monetary impact of wildlife on S. C. (ex. hunting, fishing, equipment stores, motels, etc.). Determine which form of wildlife use - consuming (hunting) or nonconsuming (photography) contributes the most to the state's economy. Where does the money go that comes in because of wildlife? What % is for management of wildlife?

Camera fans may wish to study animal photography and construct a slide demonstration of local wildlife and their habitats. They may also give tips for wildlife photography and enter the Wildlife Federation contest.

Zoo role play activity.

Build a controlled environment such as mini zoo, terrarium or aquarium.

RESOURCES

S. C. Wildlife Federation

Zoo role play activity p. 331

636

CONTENT

People are responsible for maintaining habitat and managing wildlife. We do not own the land or the wildlife that inhabit the land. They are ours to enjoy on a temporary basis. They are our legacy and must be managed for future generations.

Wildlife management is a public responsibility involving state, federal and international cooperation and legislation.

637

STUDENT OBJECTIVES

The student will be able to:

Recognize that individual efforts and group efforts are important in maintaining wildlife resources.

STUDENT ACTIVITIES

Have a debate on the pros and cons of caging a normally free animal.

Debate: It has been decades since the last sighting of an ivory-billed woodpecker. A hunter has just captured a male ivory-billed and for all intent it is considered the last of its kind on earth. Should this bird be placed in a major zoo so it can be preserved following its death, or should it be released to spend its last days in its native habitat flying free?

Debate: (and/or discuss)
Should we manage?
What should be managed?
What can not be managed?

Interview real estate developers concerning preservation of habitat. Visit a construction site to see what is being done to preserve habitat.

RESOURCES

638

PLANNING A ZOO - A ROLE-PLAYING EXPERIENCE

Your community has been given a grant from the federal government for a zoo. The community leaders have announced a public meeting to be held in order to hear ideas for the zoo. Plans may be submitted by anyone. Plans must include the following information:

1. What types of animals are to be in the zoo?
2. What type of setting is to be provided for the animals?
3. Where is the zoo to be located?
4. What is the name for the zoo?
5. Why should the plan be adopted?

The principal has asked your teacher to develop a plan and since your teacher feels the zoo is to be for you, your class has been asked to develop your school's plan for the zoo. There is only one problem; the meeting has been scheduled in 5-10 days. So you must work quickly but with a lot of thought. Good luck.

CONTENT

STUDENT OBJECTIVES

The student will be able to:

Describe methods by which groups may influence the welfare of species.

Describe the functions of government and non-government organizations in regard to wildlife preservation and management.

Describe international law which governs wildlife not indigenous to one nation (ex. migratory animals).

STUDENT ACTIVITIES

Invite representatives of the following organizations to speak to the class - or interview them. Find out their major goals -

how many members?

major activities?

lobbying activity? If so what major legislation are you concerned about now?

printed materials?

attitude toward hunting?

Discuss or debate: The boundary between Georgia and South Carolina as it affects fishing and shrimping rights.

Trace the history of wildlife legislation in America.

Look up international and federal laws regarding wildlife management. Discuss their effectiveness.

RESOURCES

Sierra Club
S. C. Wildlife Federation
Audubon Society
Humane Society
Others

CONTENT

Wildlife is a public resource controlled by the state.

643

STUDENT OBJECTIVES

The student will be able to:

Describe current wildlife problems needing international cooperation.

Identify laws in S. C. that protect and regulate wildlife.

Describe the Heritage Trust Program in S. C.

333

STUDENT ACTIVITIES

Discuss fishing rights and the international difficulties involved in fishing.

Read and research information on the whaling industry and the "Save the Whale" movement. Report to the class and suggest international resolutions to this problem.

Find out what legislation and financing is provided by S. C. for non-game species.

Debate the legislation that affects trapping in S. C.

Discover by letter or research the legislation protecting and regulating wildlife. Discuss whether it is adequate for maintaining sufficient habitat.

Bring a legislator and member of the Wildlife Department to class to discuss wildlife legislation and regulation.

View the film S. C. Heritage and discuss its impact on wildlife and the future activities of South Carolinians.

RESOURCES

Jones and Murphy, Geography and World Affairs, p. 252.

S. C. Heritage - S. C. Wildlife Department.

644

CONTENT

Management of renewable resources can have varied impacts on wildlife. Ex. Forest management, soil and farm management -- such as harvest methods, controlled burning, etc.

Wildlife management includes:
Inventory and census of species
Yield determination
Data interpretation
Recommendations for management.

People - their presence and activities affect habitat and thus wildlife.

STUDENT OBJECTIVES

The student will be able to:

Explain how resource management affects wildlife populations.

Explain how human activities may affect wildlife and their habitat.

STUDENT ACTIVITIES

Discuss with one or more farmers methods used to protect wildlife, ex. hedgerows.

Interview a forester and wildlife conservationist to determine the claimed affects of clear cutting and controlled burning on wildlife.

Experiment with several aquaria (or glass jars) of fish and necessary vegetation. Check experimental jars for the effects of detergent on fish. Discuss the impact of this impact on wildlife. List the many activities of people that have an adverse affect on wildlife.

RESOURCES

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

OTHER ACTIVITIES

- a. Make a bird calendar.
Indicate:
Date and time and location of sighting. Was bird migrating, seasonal, year round? Describe its behavior - flying, perching, eating, etc.
- b. Construct eagle wings or other animal costumes used by Indians in their dances and teach the class something about the culture of the Indian as it relates to wildlife.
- c. Create a television commercial to support wise management of wildlife.
- d. Find out what S. C. was like when the settlers first came. What activities did they engage in and how did these impact on wildlife (ex. timber cutting and farming)? What was the attitude of the pioneer toward the land and wildlife? What is your attitude today? Do they differ? How? How would you describe the national attitude toward wildlife?

RESOURCES

A WILDLIFE SIMULATION ACTIVITY

(Adapted from An Environmental Syllabus, New York Dept.
of Education)

The purpose of this simulation is to provide the students with an opportunity to consider the economic value of a species threatened with extinction. Provide the students, who will be working in groups of five, with the following worksheet:

You are members of a newly formed federal commission directed by the President to save endangered species through the administration of government funds. Below are listed fifteen North American species rated as "endangered" and an approximation of the funds necessary to guarantee their protection and survival.

Brown Pelican	\$ 500,000
Bald Eagle	900,000
Blue Whale	1,500,000
Blue Pike	150,000
Green Turtle	300,000
Florida Manatee	1,000,000
Grizzly Bear	1,000,000
Polar Bear	250,000
Caribou	750,000

Lake Sturgeon	\$ 750,000
American Alligator	1,500,000
Bog Turtle	190,000
Prairie Chicken	100,000
Peregrine Falcon	350,000
Mountain Gorilla	400,000

1. You have been granted a budget of five million dollars for a period of one year.
2. After researching the economic, aesthetic, and general environmental worth of each animal, develop a system for selecting as many of these endangered animals as possible with your five million dollars appropriation. Individual species cost estimates cannot be altered.
3. List your reasons for each animal selected for survival and for each animal left to probable extinction.

4. Each species must be selected by at least a four-fifths vote.
5. If time is available, outline how you would use the money assigned to one of your selected animals.

Class Discussion

Share your plan with the class.

Identify endangered species in South Carolina.

Why was a monetary approach to the problem used in this activity?

MAKE A PLASTER CAST OF TRACKS

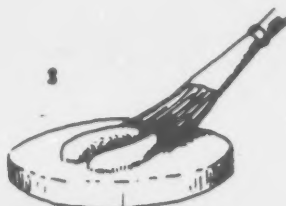
- 1 Make a circle with 2-inch strip of cardboard and paper clip. Press this into soil to make a form.
- 2 Mix about 1 2/3 parts plaster of paris and 1 part water to make thin batter. Snow will melt when plaster is poured unless you use lots of snow to cool plaster, or dust dry plaster of paris in print to make a base. Pour mixture carefully over print.
- 3 When plaster is hard (depends on your batter) lift cast and carefully remove cardboard. Clean gently with a brush. This is a negative cast.
- 4 To make a positive cast, coat negative with vaseline and repeat the casting process.
- 5 When hard, remove cardboard and separate carefully. Now you have a positive cast which is a duplicate of the original print.



1



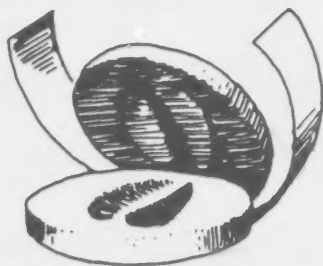
2



3



4



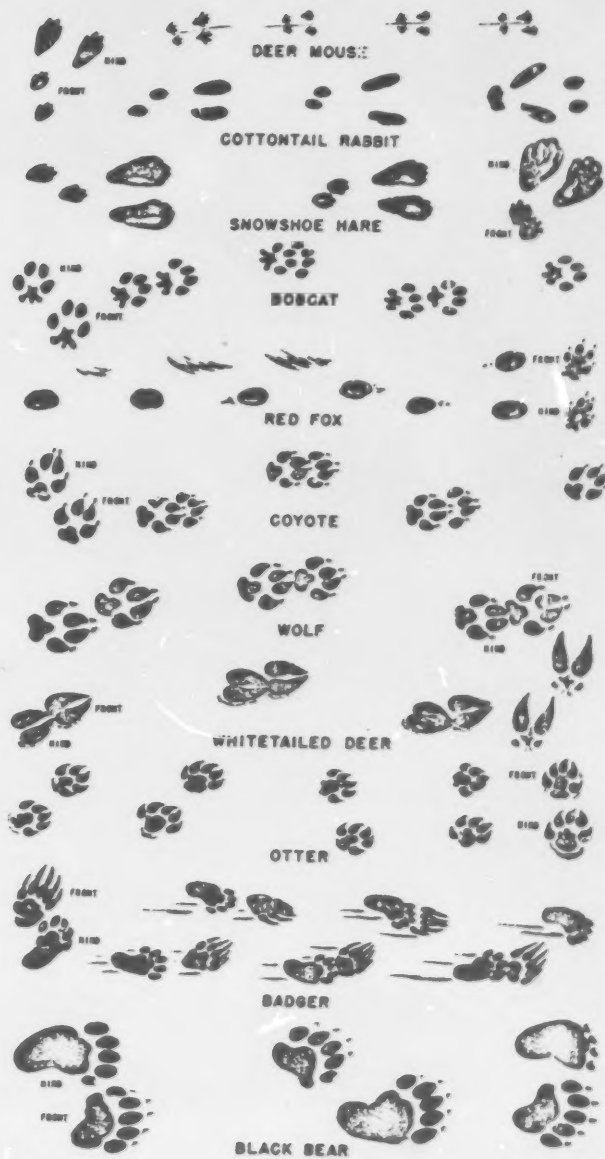
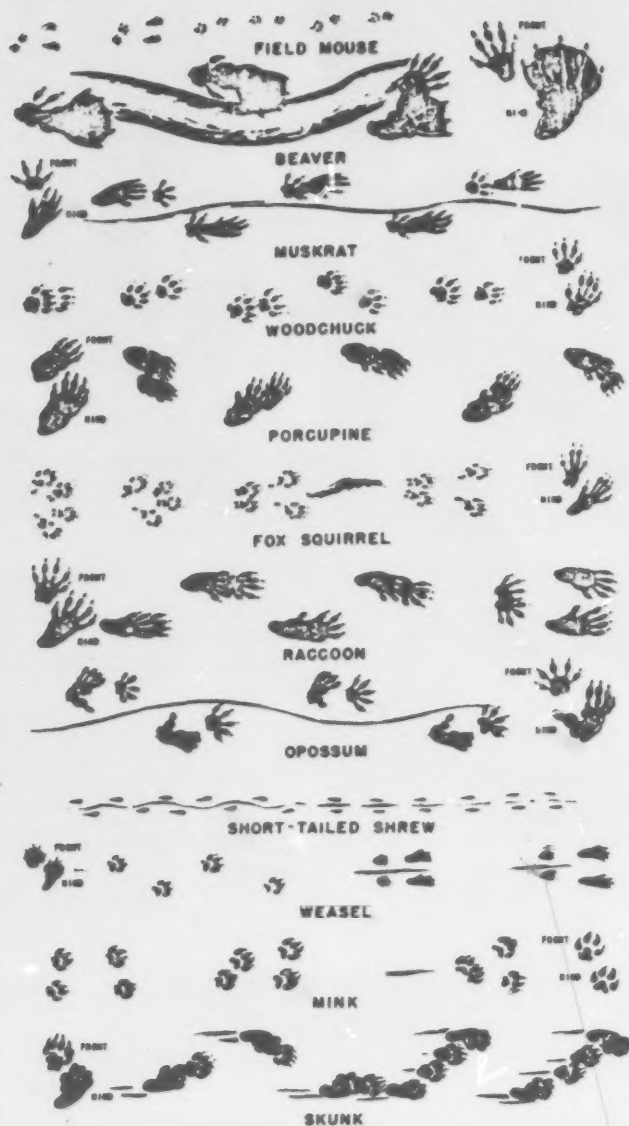
5

Appreciation to Texas Parks and Wildlife Department for animal drawings and to Robert G. Wingard of Pennsylvania Forestry and Wildlife Extension Service and C. R. Studholme and W. M. Sharp of U. S. Fish and Wildlife Service for Format.

The S. C. Wildlife Resources Department, James W. Webb, Executive Director, Information and Education Section, P. O. Box 167, Columbia, S. C. 29203

652

Educational Series 60



SOUTH CAROLINA'S WILDLIFE RESOURCES

HABITATS

by Darrell Holt

Introduction

The word "Ecology" comes from two Greek words that mean "the study of the home." Therefore, Ecology could be defined as a study of "your home." Your home is not only a residence of board, brick, mortar, and nail, but a world-wide home shared with many many other organisms. (An organism may be either redbird at a window feeding station, a gray squirrel eating an acorn on an oak branch, a rose growing in your back yard, or even your dog or cat.)

The roof of our home reaches to the highest limits of the sky where great birds soar. The basement of our home is the soil and is as deep as the deepest roots have penetrated.

Ecology is a new science, and has to do with the study of the interrelationships of everything in our "Biosphere." (A biosphere is that portion of the earth, as we know it, in which the living and non-living act together as a whole.) Every day we see and learn about this complex system of air, soil, water, sunlight, plants, and other animals.

This pamphlet was written to help you--man, who is more widespread over the earth than other organisms, to understand and appreciate his environment before it is too late. Man is constantly changing this environment at the expense of natural resources. Some of these resources such as soil, water and minerals, can never be replaced.

Ecological Divisions

Our "ecological home," the world, is occupied by so many kinds of life the ecologists have divided it into six "realms" for better understanding. These realms nearly correspond to the six continents.

Each realm contains plants and animals that evolved under that area's specific set of conditions. The differences among plants and animals in each realm are due to barriers such as mountains, rivers, oceans that either slowed or stopped movement, or migration. If the animals could not adjust or move to a more suitable environment they became extinct. Can you name any of these animals?

In North America we live in the Nearctic realm along with the giant redwood, muskrat, rattlesnake, and mockingbird. Do you know the other five realms? In this Nearctic realm are found more than 400 kinds of mammals, 200 reptiles, 800 of birds, 140 of amphibians, 150,000 groups of insects and thousands of different varieties of plants.

The ecologists have further divided each realm into "Biomes", each biome being a region with plants and animals that are influenced by the climate and the different kinds of soil. Climate meaning the different amounts of rainfall, temperature, and sunlight.

There are six major land biomes found in the Nearctic realm--the tundra, coniferous forest, deciduous forest, grassland, woodland, and desert. In what biome is South Carolina located?

In each biome are found many "Communities," each occupying an area or areas with special physical land features. This area is called the habitat of the plant or animal. The role a plant or animal plays in its habitat is called its "niche." In other words, a niche is an organism's "profession" or "job." For example, the habitat of the eastern chipmunk is in the northwestern part of the state and one of its roles is that it is food for the hawks, snakes, and foxes. Another role is that the chipmunk is an active spreader of plant seeds.

Man's niche should be to provide a healthy habitat for plants and animals and for himself. Unfortunately, he is rapidly changing the environment to serve his own needs by polluting the air, draining swamps and marshes and spraying pesticides.

Mountains

The beautiful Blue Ridge Mountains in the northwestern one-third of Oconee, Pickens and Greenville Counties provide 500-square miles of habitat for the wildlife, plant life, and people of South Carolina. From the tallest white pine on the upper slopes of Sassafras Mountain to the lichen-covered rock outcropping in the foot-hills, the approximately 450-million-year-old home is unique as no other in the state.

Every home must have an ample water supply and the Blue Ridge habitat is no different. The 12,000 surface acres of rivers, streams, and ponds are fed by approximately 70 inches of rainfall each year. In the cold water streams and rivers are found rainbow trout, brown trout, and the native brook trout. In the warmer water rivers, such as the White Horse, and in ponds can be found bream, catfish, and gamey largemouth bass. Do you know the temperature difference in a cold and warm water stream?

In a two or three storied home the temperature in the basement will vary greatly to that temperature in the attic. And this holds true for a mountain. As you go up a mountain there is a three to five degree drop in temperature for every thousand feet of altitude. Another reason for it being colder at the top of a mountain is that the air is drier and will not hold the heat as readily. Also, the temperature of one mountain will differ from that of another because of location, wind and many other factors.

And as the weather is different on a mountain, there are different kinds of soil, which help bring about different kinds of plant life.

In the "Blue Ridge Habitat" the trees are mostly hardwood on the ridges and the slopes facing south and white pine intermixed with hardwood on the slopes facing north and in the coves. Can you name some of the hardwoods found in the mountains?

Yessir, Mother Nature has provided quite a complex housing project for the wildlife of the Blue Ridge Mountains.

In the forested areas you might see a graceful white-tail deer, or a beautifully colored wild turkey. If you are in a remote area you might even get a glimpse of a black bear as he rumbles away.

Around farming communities or in cut forested areas where secondary growth has begun you might see a family of bobwhite quail, cottontail rabbits, and cheeky chipmunks carrying seeds to their burrows for storage.

One has to be careful too, because eastern timber rattlesnakes like to feed on the abundant rodents found in this habitat.

Of course, the snakes and rodents have to be wary because the top floor dwellers--the hawks--feed in these areas. At night the hawks give way to the owls, who patrol the night and fill the air with their weird sounds.

Yes, you can hear this sound and many more when you visit the home of the wildlife and plant life in the Blue Ridge Mountains of South Carolina.

Piedmont

The Piedmont section of South Carolina includes 5,700 square miles of habitat from the foothills of the mountains to the fall line near the center of the state. What is meant by the geologic term "fall line"?

This habitat's basement is made up of rolling hills of mostly clay and sand with many scattered woodlands and small farms.

Generally, the soil is not very fertile and for plants and trees to obtain their full growth they must have proper soil nutrients. But, with the many woodlands and farms there comes about a condition called the "edge effect" and this is ideal habitat for wildlife.

An "edge" is where there is a quick or gradual change of plants and trees between two or more different vegetative communities. For example, honeysuckle will not grow well in a mature swamp or on dry sandy upland area but does well in an area between the two.

If one of your favorite hobbies is watching wildlife this is the place to see the most kinds and the greatest numbers.

If you are real quiet you might see the dainty white-tailed doe with her fawns. She uses the swamp to hide her young ones during the day and when dusk begins to arrive she will leave the swamp to feed. Of course, you have to be very quiet and look hard because the lighting is not very good. Also, you do not want to miss a flock of turkeys that passes through this area on their way to their roost, which is located in the swamp.

Another day you might see a red-tailed hawk sitting on a tall, dead pine tree that overlooks the area. With his sharp eyes ever searching, a cotton rat, or white-footed deer mouse dinner may only be a wing beat away.

These are just a few of the many animals which visit the edge and could be called "edge species." Can you name some other edge species?

A word of advice when you go wildlife watching. You are entering another organism's home so be on your best behavior. Don't needlessly destroy a dead tree home, a burrow, and always pick up your litter so that others may enjoy nature's wonders.

Swamps

Swamps have long been feared and held in awe as a dark mysterious wetland. Authors and movie makers have not helped by making swamps the villain in their works.

Do you know what a swamp is? It's simply a fresh water marsh with trees. If it is an old swamp, there will be giant cypress, gum and oak trees.

Swamps are formed many different ways. Many of the Savannah River swamps were formed because the river changed course and left some water in the abandoned channel. Actually, a swamp may be formed from any fresh water area such as a large lake or water collected in low lying areas, which gradually filled in over the years. And just think there are over two million acres of this type of wetland in South Carolina.

Enter a wildlife biologist's canoe and let us visit one of these fascinating and beneficial habitats. A canoe will enable us to get closer to the wildlife than if we were on foot.

As we quietly paddle underneath the tree canopy you will see little two to ten foot hills scattered throughout the swamp. These are called knolls or hummocks and are places where spongy soil can support grass, shrubs, or trees.

Some of these areas are several acres in size and are the homes for deer, wild hog, bobcat, and reptile.

In a remote swamp you might be lucky and spot an alligator sunning on the bank. Or catch a glimpse of his nostrils and bulging eyes above the water before he submerges. There is no need to fear because these reptiles will seek escape when confronted by man.

As you float silently along don't forget to notice the different kinds of plant life. The beautiful and rare lilies and orchids. The tall and sentinel cattails where chattering wrens or red winged blackbirds build their homes.

If you look closely in the towering cypress trees you can see the holes made by pileated, redheaded, or downy woodpeckers while hunting for insects.

Later, these holes will enlarge through decay and become the homes for wood ducks, screech owls, and other woodpeckers.

As you leave the swamp and the sunlight floods about you, it will make you realize how important all wetlands are in the scheme of life.

Saltwater Marsh

What habitat is the home of animals ranging in size from an alligator twice as long as a man is tall, to insects so small that they can hardly be seen under a microscope? It's South Carolina's 500,000 acres of saltwater marsh.

The tidal marshes rarely exceed ten miles in width, but they extend 190 miles from the Georgia line to the North Carolina line.

How did the tidal marshes come into existence? Millions of years ago barrier beaches and sea islands, such as Bull Island, started developing and became buffer zones or shelters between the mainland and the cruel Atlantic Ocean.

Rent a small boat from any of the numerous docks in the picturesque coastal towns and travel into the marsh to see and learn about one of the most important natural resource areas in South Carolina.

At first glance, as you start inland, a sea coast marsh appears to be a flat expanse of water, mud, grass, and barren stalks of plants. But, pound for pound, an acre of unpolluted saltwater marsh can produce four times as much food as an acre of rich cornland. It is true because at the coast's edge material from two habitats--ocean and land--mingle and become one. Each day the moon pulls the tide in from the Atlantic Ocean, and the rich sea waters flood the low flat places. Later the moon pulls the waters away carrying some of the living and dead, but most important, leaving rich mineral and salts behind. Did you know that in a single cubic mile of sea water there is enough gold (\$93 million) to fill Fort Knox? Also, coastal waters are rich in iodine, iron, and magnesium.

As you advance deeper into this horn-of-plenty you will be able to see birds varying in size from the cheerful four-inch long wren to the graceful giant blue heron. You can see the rare eastern brown pelican diving for fish. If you look closely on the shore you can see empty shells of crabs, clams, and other aquatic organisms.

Stop and study the many interesting kinds of plant life. There are strips of sea lettuce, sea moss, remains of green algae, and the always present cord grass. Pay special attention to the pattern of plant growth; how some plants grow only close to the water's edge, while others grow farther back on well-drained soil.

As you see, admire, and learn about all these things, let the shells of the dead sea animals be a reminder. A reminder, that even though the animals are now dead, they once lived. They were born, struggled for existence, and finally died. Man, who shares this same bond, owes the same chance to all his fellow creatures, no matter how big or small.

South Carolina Wildlife Resources Department
Information and Education Section
P. O. Box 167
Columbia, SC 29202

REFERENCES

- Allen, D. L. Our Wildlife Legacy. New York: Funk and Wagnalls, 1962.
- Bailey, J. A.; W. Elder and T. D. McKinney, eds. Readings in Wildlife Conservation. Washington, D. C.: The Wildlife Society, 1974.
- Benson, Delwin E. Helping Wildlife: Working with Nature. Washington, D. C.: Wildlife Management Institute, 1977.
- Buchsbaum, Ralph and Mildred. Basic Ecology. Pittsburgh: Boxwood Press, 1975.
- Dasmann, R. F. Wildlife Biology. New York: John Wiley and Sons, 1964.
- Errington, P. L. Of Predation and Life. Ames, Iowa: Iowa State University, 1967.
- Farb, Peter. Ecology. New York: Time-Life, 1970.
- Fisher, J.; N. Simon, and J. Vincent. Wildlife in Danger. New York: Viking Press, 1969.
- Horwitz, Eleanor, ed. Ways of Wildlife. New York: Citation Press/Scholastic, 1977.
- Laycock, G. America's Endangered Wildlife. New York: W. W. Norton, 1968.
- Leopold, A. Game Management. New York: The MacMillan Co., 1933.
- Leopold, A. A Sand County Almanac and Sketches Here and There. New York: Oxford University Press, 1966.
- Matthiessen, P. Wildlife in America. New York: The Viking Press, 1959.
- Miller, G. Tyler, Jr. Living in the Environment, Concepts, Problems and Alternatives. Belmont, California: Wadsworth, 1975.
- Miller, G. Tyler, Jr. Replenish the Earth - A Primer in Human Ecology. Belmont, California: Wadsworth, 1972.
- New York Department of Education. Environmental Syllabus: Grades 10, 11, and 12. Albany, New York: 1976.
- Odum, Eugene P. Fundamentals of Ecology. 3rd ed. Philadelphia: W. B. Saunders, 1971.

- Spilhaus, Athelstan. "Ecolibrium." Science, Vol. 175, pp. 711-715.
- Storer, John H. Man in the Web of Life. New York: Signet, 1968.
- Storer, John H. The Web of Life. New York: Signet, 1953.
- Strohm, J., ed. Endangered Species. Washington, D. C.: National Wildlife Federation.
- Teague, R. D., ed. A Manual of Wildlife Conservation. Washington, D. C.: The Wildlife Society, 1971.
- Time/Life Books. Life Nature Library. New York: 1961-1973.
- Trefethen, J. B. An American Crusade for Wildlife. New York: Winchester Press, 1975.
- Trefethen, J. B. Wildlife Management and Conservation. Boston: D. C. Heath, 1964.
- Wildlife Management Institute. Placing American Wildlife Management in Perspective. Washington, D. C.
- Ziswiler, V. Extinct and Vanishing Animals. New York: Springer-Verlag, 1967.

RESOURCES FOR WILDLIFE UNIT

From: S. C. Wildlife and Marine Resources Department, P. O. Box 167, Dutch Plaza, Building D, Columbia, South Carolina, 29202.

Concepts in Environmental Education

Wildlife Tracks

Bird Beaks

Endangered Species Newsletter of South Carolina

South Carolina Wildlife - every issue contains relevant information.

Kodak Camera Company - Here's How.

Miller, G. Tyler. Living in the Environment, Concepts Problems and Alternatives, Wadsworth, pp. E86-93, and Chapter 10, pp. 163-168.

U.S. Forest Service - Investigating Some Animals and Their Environment.

S. C. Wildlife Federation, Suite 211, Dutch Plaza, 800 Dutch Square Boulevard, Columbia, South Carolina, 29210.

670

CHEMICALS AND YOU

Overview

Dozens of chemical compounds, used to control harmful organisms, have become the targets of environmentalists. The best known of these chemicals is DDT, credited with virtually eliminating malaria and typhoid among American soldiers during World War II. This same chemical is credited with saving billions of dollars of crops from destruction by pests. There are numerous other pesticides, less commonly known, in widespread use in this country and the world.

In June 1969 16 substances, DDT and 2, 4, 5-T included, were banned by the Interior Department from use on the more than 500 million acres of land it controls. Another group of pesticides was classified as "restricted."

Some other chemical contaminants of the environment that have come to public attention are:

Mercury - A natural element, toxic to living organisms, was once widely used by the agricultural industry as an inhibitor. It has been used in pesticides and in paint and varnish to slow down undesirable growths. The toxicity problem of mercury waste is that it is taken up by microorganisms, converted to methylmercury and enters the human food chain.

Lead - One of the most common poisons that man puts into his environment. It comes from many different sources: leaded gasoline (automobile exhausts), lead based paint from old houses, from making moonshine whiskey, pottery improperly glazed with leaded glasses, and various industrial sources.

Sulfur Oxides - poisonous gases resulting from burning sulfur or cheap fuels containing sulfur.

The above are covered in this unit with the hope that other chemical contaminants will be added according to their relevance in your community.

Note to teacher -

1. Before starting units on Solid Wastes and Environmental Chemicals, obtain a copy of Environmental Film Listings from: Emphasis / South Carolina
Box 113, Edgar A. Brown Building
1205 Pendleton Street
Columbia, S. C. 29201
Phone: 758-8815
2. You may request a copy of "McDonald's Ecology Action Pack" from your local McDonald's. This book contains background, activity ideas and spirit masters for six different ecology units.

CHEMICALS AND YOU

Part I

Pesticides:

Overview

The term pesticide is generally applied to a variety of pest control measures including chemicals for killing insects (insecticides), chemicals for killing plants (herbicides), those used to control fungi (fungicides), and chemicals for killing rodents (rodenticides).

Pesticides have provided many important benefits to man. They have helped increase crop yields and helped to control dread diseases in both plants and animals. Although pesticides are beneficial, there may be significant disadvantages in their use. Using pesticides has caused problems such as adverse effects on human health, wildlife and the environment. Examples of these adverse effects include increasing genetic resistance of insects to the chemicals and destruction or disruption of naturally occurring control agents.

The effort now is to keep pest populations to tolerable levels without jeopardizing human health or wildlife and without appreciable economic losses. Techniques being used include:

- ... beneficial insects-predators or parasites
- ... insect infections-bacterial, fungal and viral
- ... pheromones-sex attractants
- ... sterilization
- ... hormones-they affect development of insects
- ... development of pest resistant crops
- ... natural repellants
- ... carefully controlled use of toxic chemicals.

CONTENT

Types of chemical substances called pesticides.

Pesticides are useful, but may also be harmful to human health and wildlife.

STUDENT OBJECTIVES

The student will be able to:

Define pesticides.

Identify the major pesticides presently being used in this community and identify problems associated with their use.

List the potential dangers and actual damages that may result from the use of pesticides.

Describe the existing local, state and national laws governing the use of pesticides.

STUDENT ACTIVITIES

Use available resource material to formulate a good definition of pesticide.

Make a chart of some pesticides which may be used with little or no known harmful effects.

Pest	Pesticide	How Used	Possible Damage

Film presentation: "Perspectives on Pesticides."

Visit your local county agent for hand-outs and sources of information.

Visit or write to your District Environmental Quality Control Office.

RESOURCES

Use material in reference list and others from your library.

Local Clemson Extension Service.
Library.
Reference list.

Check list of films in reference.

S. C. Department of Health and Environmental Control, Columbia.

CONTENT

Natural biological control of pests can reduce the need for use of pesticides:

Interplanting
Homemade insecticides
Natural agents
Mechanical control

STUDENT OBJECTIVES

The student will be able to:

Identify and use natural biological controls of pests as well as other means of pest control.

Understand how some organisms control pests.

STUDENT ACTIVITIES

List organisms in your community that are natural biological or other controls of pests. Chart your findings.

Example:

Pest	Natural Biological and Other Controls
1. Ant	Mix equal parts of Cock- powdered sugar and roach borax. Spread in corners and around baseboards.
2.	
3.	

Collect and observe some natural enemies of insects--ladybugs, dragonflies, etc.

Construct a "rearing cage."

Cut plastic to desired size, roll into tube, glue with cement.

Sew or glue a cheese cloth sleeve to each end of tube.

Slide entire tube over brand of plant (enclosing pests and enemies).

RESOURCES

"Keeping the bad Bugs out...Naturally," Johnny Horison Program, Information Sheet U, Washington, D. C. 20240, 1976.

Sheet of clear plastic, acetate cement, cheese cloth, ties.

677

678

CONTENT

Pesticides should be used very carefully. It is important to follow the manufacturers directions without any deviation.

679

STUDENT OBJECTIVES

The student will be able to:

Use pesticides more wisely and safely.

353

STUDENT ACTIVITIES

Make several cages and place on different branches.

Observe and chart your observations daily or weekly.

Set up a demonstration that may be used to educate your community on the safe use of pesticides.

Make a survey of pesticides used in your neighborhood. Chart your data showing (a) regularity of use, (b) whether use is corrective or preventive, (c) safety precautions followed.

Make a list of ecologically sound methods of pest control and work out a plan of action to reduce the usage of high risk pesticides and to educate your community about more ecologically sound pest control measures.

RESOURCES

The No-Poison, No-Pest Garden.

680

CHEMICALS AND YOU

Part II

Mercury:

Overview

Mercury, one of the most versatile useful natural elements, is toxic to humans even in very low concentrations.

By the end of 1970, the Federal Water Quality Administration discovered high mercury concentrations in lakes and streams throughout the U. S. The Justice Department filed lawsuits against some of the nation's largest corporations, and the FDA seized several million cans of contaminated tuna and tons of fresh swordfish.

Dangerous concentrations of mercury in freshwater fish throughout the U. S. have thrust serious economic problems upon commercial fishermen and their families, wholesale fish dealers, sport-charter boat operators, motel owners, and small businessmen dependent upon commercial recreational fisheries.

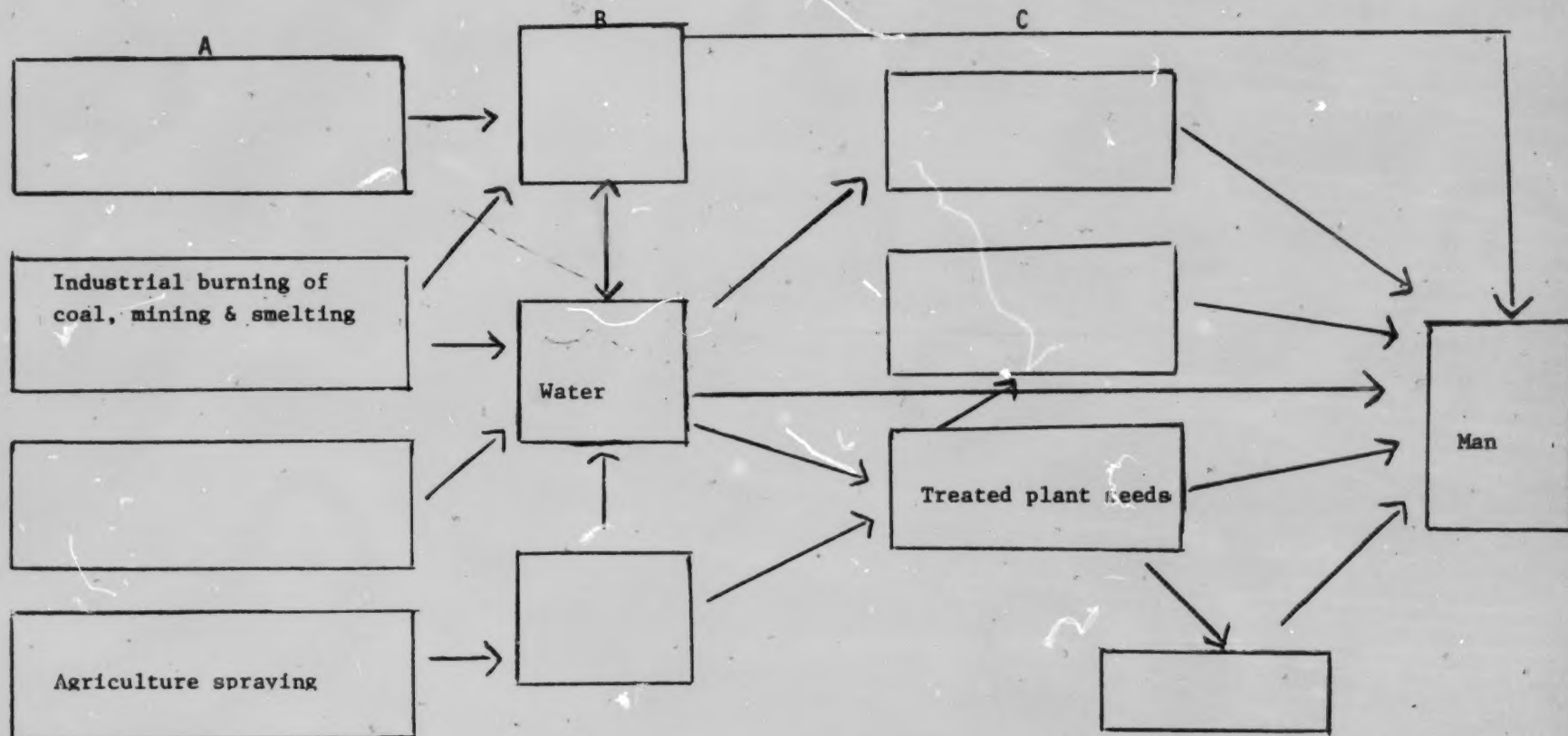
The present major known sources of mercury in the environment are (1) natural geologic formations, (2) industrial discharges, (3) pesticides, (4) residues from use in gold and silver mining, (5) miscellaneous garbage, and (6) the burning of fossil fuels.

Mercury may be introduced into the environment in a variety of forms but may be transformed into deadly methyl-mercury which moves freely up the natural food chain. Methyl-mercury causes irreversible damage to the nervous system and brain. In the high concentrations it causes convulsions, blindness, coma, and death.

Concepts:

1. Mercury is toxic to humans, even in low concentrations.
2. Mercury comes from many sources and enters the human food chain.
3. Environmental regulatory agencies take steps to reduce harmful levels of mercury in our environment.
4. Individuals can help reduce mercury contamination in our environment.

How Mercury Reaches Man



1. treated plant seeds
2. water
3. natural weathering of soils and rocks
4. livestock
5. burning of garbage and trash
6. air

7. man
8. agricultural spraying
9. soil
10. game birds and animals
11. industrial burning of coal, mining and smelting
12. commercial and game fish

Directions: Place the items in the list on your left in the proper rectangle.

"A" spaces are sources of mercury
 "B" spaces are intermediate between sources and the food chain.

"C" spaces are ways that mercury reaches people directly.

CONTENT

Mercury, once believed to be harmless is poisonous.

Mercury enters the human food chain from many sources through air, water and soil:

- a. agricultural spraying
- b. industrial burning of coal
- c. mining and smelting
- d. natural weathering of soil and rock
- e. burning of garbage and trash

We can help reduce the transfer of mercury from the environment to humans.

STUDENT OBJECTIVES

The student will be able to:

Recognize that mercury is harmful to humans.

Recognize the sources of mercury in the environment

Understand how mercury is incorporated into the human food chain.

Use the knowledge gained about mercury pollution to take action in helping reduce contamination by it.

STUDENT ACTIVITIES

Conduct research and discuss your finding with the class on the effects of mercury on animal life and man.

Have your teacher contact your District Environmental Control personnel and make arrangements for him to speak to your class. Find out:

- a. The exact sources of mercury in your local air, streams, rivers, and lakes.
- b. The levels of mercury found in your local environment.
- c. Measures taken by the EPA and community agencies to correct mercury contamination.

Complete the chart "How Mercury Reaches Man."

List ways that individuals can help reduce the entrance of mercury into the human food chain.

RESOURCES

See bibliography for references.

S. C. Department of Health and Environmental Control, 2600 Bull St., Columbia, S. C. 29201.

Copies of chart "How Mercury Reaches Man."

LEAD

Overview

Lead poisoning is a major cause of brain damage, mental deficiency and serious behavioral problems. It also causes inhibition of enzyme activity, anemia and kidney malfunction. Four hundred thousand children are affected yearly by lead poisoning. Well-defined groups having an immediate and urgent problem with this chemical are: (1) young children, 1-5 years of age who live in dilapidated housing where they nibble chips of leaded paints; (2) whiskey drinkers who consume quantities of lead-contaminated moonshine; (3) people who eat or drink from improperly glazed earthenware and; (4) workers in certain small-scale industries.

The chief natural sources of lead poisons include silicate dusts from soil erosion, and volcanic eruptions. Lead poisons enter the environment of humans from auto emissions (principal source of all air-borne lead), coal combustion, manufacturing, pesticide sprays, waste incineration, lead-base paints, lead soldered food containers, contaminated food, lead-smelting, and the burning of old battery casings.

CONTENT	STUDENT OBJECTIVES	STUDENT ACTIVITIES	RESOURCES
Lead poisons are harmful to human health.	The student will be able to: Explain how lead taken into the body causes serious damage.	Conduct research to find out how lead affects the body. Report your findings to the class.	Local libraries.
The sources of lead in the environment: Natural Man-induced.	Identify the sources of lead that contaminate soil, air, and water in his environment.	Conduct research and report to the class on "how lead poisons get in our immediate surroundings and into our bodies." Consult your county farm agent or local home extension center to determine if any lead containing pesticides are used in your area.	Local health department.

CONTENT

Treatment for lead poisoning is not effective; PREVENTION IS A MUST!!!

690

STUDENT OBJECTIVES

The student will be able to:

Determine means of preventing lead poisoning through individual and community efforts and legislative procedures.

359

STUDENT ACTIVITIES

Organize a debate concerning who should be responsible for chemical pollutant control.

List some alternatives to the use of lead-based consumer products.

List some things you can do about lead contamination in your home.

Look up federal and state legislation governing the manufacture and use of leadbased consumer products. Discuss the adequacy of the legislation.

Work out and implement a plan to inform your community about the hazards of lead poisoning and how the community can help prevent these hazards.

RESOURCES

691

Lead Poisoning:

State Takes Closer Look At Serious Health Hazard

By MARGARET N. O'SHEA
Governmental Affairs Staff

Lead poisoning among children has reached epidemic level in the Charleston area and is apparently a serious health hazard in older sections of other South Carolina cities as well, screening statistics indicate.

Public health implications are drastic enough to warrant regulations against lead-based paint and other leaded materials in housing and areas where youngsters are likely to be exposed to them, according to officials from South Carolina Department of Health and Environmental Control (DHEC) and the Medical University of South Carolina (MUSC).

They also advocate extensive educational programs for parents, but the problem isn't likely to go away without "regulatory action designed to eliminate exposure sources." Proponents of that sort of legislation in both the House and Senate last year found considerable opposition, however, among colleagues who fear a lead-control act would reach too far into the private lives of homeowners.

In the Senate, the legislation bounced

Hundreds of South Carolina children are being slowly poisoned each year by eating lead or absorbing it into their bodies. A common source is lead-based paint, which children are tempted to eat when they see it cracked and peeling off the walls or sides of a house. Lead poisoning at best makes children sick. At its worst, it can cause brain damage or death.

from the committee that handles medical affairs onto the floor and into the Judiciary Committee. The House version is also in Judiciary.

The proposed legislation, whose major author is Sen. James B. Stephen, D-Spartanburg, would prohibit persons from selling a dwelling or building if the exterior finish contains a lead-based substance and requires anyone selling substances containing lead to say so.

Medical and public health officials who have been involved in screening youngsters throughout the state for poisoning hope the Stephen bill ultimately

passes, having seen first-hand over the past several years what can happen to children who are exposed to the element.

Mild forms of lead poisoning cause anemia, drowsiness, muscle cramps, abdominal pain, constipation, loss of appetite and persistent vomiting. Undetected and untreated, lead poisoning becomes severe, leading to brain damage, coma, convulsions and sometimes death.

What happens when lead is absorbed into the body is simple: It stays there.

Even small amounts absorbed over a long period of time are dangerous. They cause the illness laymen know as lead

poisoning and doctors refer to as plumbism.

Sources of lead abound in inner cities, slum areas and older sections where housing is often cheaply constructed, poorly maintained and likely last painted with leaded paint that has begun to crack and peel. In addition to deteriorating housing, the urban core is subject to high traffic levels and significant automobile exhaust fumes containing vapors from leaded gasoline.

The child who eats paint chips or chews on lead-painted objects, such as the older toys that may be the only ones a poor child owns, will develop abnormal levels of lead in the blood, urine, bones and tissues, even in the line where his teeth protrude from the gums.

Other sources of the potentially lethal element are airborne particles, dusting paint, soil or improperly fired earthenware eating and drinking utensils. Tea drinkers can get lead poisoning from the action of tannic acid in tea on glassware with lead-painted designs if they are glazed inside the glass or on

(See LEAD, 3C, Cont.)

Lead Poisoning

(Continued From 1-C)
cracked and chipped ceramic cups.

For children, whose bodies are smaller and tolerance less, years — if they come to pass — can be too long.

The old, lower income area of historic Charleston has long been known for a troublesome statistic to health officials in the state — a high incidence of childhood lead poisoning among youngsters who live there.

In the decade between 1960 and 1970, hospitals in the city admitted 70 children — some of them several times — with severe lead poisoning. Among them, those 70 children were in the hospital 114 times, and 11 of them died. Most of the rest were brain damaged, according to the August issue of the Journal of South Carolina Medical Association in an article prepared by DHEC Interim Commissioner Dr. Lamar E. Priester with Norris H. Whitlock and Dr. J. Roult Reigart, both of MUSC.

Whitlock is director of a federally funded screening program for lead poisoning and Reigart is an associate professor in the Department of Pediatrics.

Of the 70 Charleston children, they said, "Virtually all of these children were in the recognized peak age range of 12-18 months (90 per cent) and most were black (86 per cent) and residents of the older peninsular area of Charleston (71 per cent).

"These data suggest that a larger group of children experienced lead exposure."

An investigation by health officials in 1970 found several school age children in the Charleston area with elevated blood lead levels, and the following year the U.S. Department of Health, Education and Welfare (HEW) included Charleston among 27 cities where childhood lead poisoning was expected to be a major health threat. The HEW study "documented the presence of a serious problem," the journal article said.

The findings:
Of 173 black children screened from an area of old, deteriorating housing, 72 (41.6 per cent) had elevated blood lead levels.

The HEW study led to a three-year federal grant, under which MUSC was to find and screen high risk children in the peninsular city. By June 1975, end of the period, 4,005 children had been tested and 919 found

to be "experiencing potentially hazardous lead exposure." Two years later, 700 are still under medical surveillance and receiving treatment as needed, and 111 have required chelation therapy for serious cases of poisoning.

DHEC and MUSC have teamed up to screen children statewide.

Using a combination of screening clinics and door-to-door contacts, the program screened 4,456 last year and found 787 with mild blood lead poisoning, 147 with more severe poisoning and overall 21 per cent with lead levels above the danger point.

The City of Charleston had the worst problem — 31.7 per cent of 969 children screened had some degree of lead poisoning, 306 in all and 66 of them with seriously high blood lead levels. In Charleston County, outside the city, 17.6 per cent of 994 children screened had lead poisoning. That was 175 children in all and 43 were serious cases.

Taken together, the Charleston area test were positive for almost 25 per cent of all 1,963 children in the screening program.

In Columbia, 28.7 per cent of 596 children screened showed lead poisoning — 171 children, 12 of them with serious cases.

In Greenville, 856 children were tested and 20.2 per cent of them had poisoning. Fourteen of those 174 cases were serious.

At Darlington, 18.4 per cent of 158 youngsters tested positive — 29 children with elevated blood lead levels, one of them seriously high.

Of 438 Spartanburg children screened under the program, 11 per cent had lead poisoning — 48 children, six with serious cases.

Only 19 lead poisoning cases were identified in Florence, where 298 children were screened for the malady, and only two in Gaffney, where 128 were screened. In percentages, Florence screenings were 6.4 per cent positive and Gaffney's 1.5. Four of the Florence cases and one in Gaffney were serious.

The program also included a catch-all category for persons in other parts of the state who were screened for lead poisoning because local health programs had identified them as potential victims, DHEC Interim Commissioner Priester said.

Of 19 "others" screened, eight had mild lead poisoning — 42.1 per cent.

The DHEC chief said finding and screening potential victims solves only part of the problem. When a child's blood shows lead content, his environment must be analyzed with x-ray fluorescence to determine where the lead is coming from, and his parents must be taught how to minimize the hazard.

But permanent abatement can be accomplished only by removal of lead-based paint and replacement with lead-free paint, paneling or wallboard.

That means home improvements, and getting landlords to spend money refurbishing housing that rents for as little as \$30 a month isn't easy.

"We have made great headway in some areas and none in

others," Priester said. "Really it depends on the personalities and the specific situation. Overall, I'd characterize the cooperation as reasonably good. The degree of cooperation is

usually related to the landlord's perception of how much the improvements will cost him."

Priester said the pending lead-control bill in the Senate,

if passed as written, would alleviate lead poisoning in time.

The bill does not address a circular problem that affects the state's poor, who are prime

targets for lead poisoning, however. That is the economics of substandard housing, which exists because there is a demand for it among those who can't afford any better.



SULFUR OXIDES
Overview

Sulfur oxides are poisonous gases resulting from the burning of sulfur containing fossil fuels burned in furnaces and factories, refuse burning, power plant coal burning, and the manufacturing of sulfuric acid.

Sulfur oxides in aerosols are prominent in the formation and duration of fogs and smogs affecting chronic bronchitis. With smoke and other factors sulfur oxides can cause lung cancer; irritation of eyes, nose; deterioration of buildings and equipment; and indeterminable ecological effects.

CONTENT	STUDENT OBJECTIVES	STUDENT ACTIVITIES	RESOURCES
Sulfur oxides are dangerous to human health, other animals and plants.	The student will be able to: Recognize sulfur oxides as a common pollutant in the air.	Test the effects of SO_2 on certain living and nonliving tissues. Immerse selected tissues into a bottle of pure SO_2. Observe the changes in each tissue after one hour. Let tissues remain in the bottle of SO_2 for 24 hrs. and observe again. What are the changes in the tissues?	Different kinds of plant and animal tissues. Natural fibers, synthetic fibers, nylon, etc., SO_2. Obtain from chemistry teacher or prepare by using Na_2SO_3 and H_2SO_4. (Use a chemistry lab manual for directions and follow precautions carefully.) Collect several bottles of SO_2.
Sulfur oxides get into the air from several sources: burning fossil fuels, refuse burning, and the manufacture of H_2SO_4.	Identify possible sources of SO_2 in his environment.	Contact your regional EPA personnel and ask for help in locating industries in your area that produce SO_2. Find out what is being done by local industry to eliminate SO_2 discharges into the atmosphere.	S. C. Department of Health and Environmental Control, Columbia, S. C. Take a field trip through your community to look for evidence of SO_2.

CONTENT

Local, state and national laws address specific needs for a more healthful environment. The Toxic Substance Control Act of 1976.

698

STUDENT OBJECTIVES

The student will be able to:

Explain legislation to protect his environment from chemical contaminants.

363

STUDENT ACTIVITIES

Seek information from EPA concerning SO₂ release in the environment.

Find out what local industries are doing to meet standards of EPA.

RESOURCES

699

SUPPLEMENTAL WORK SHEET

(Good for units on solid wastes and hazardous chemicals)

The following are measures for the prevention or correction of certain pollution problems. Cross out the less desirable measure in each case, from a long-range point of view.

<u>Problem</u>	<u>Measures</u>
1. Photochemical smog	1. Clean up fumes from autos and factories; move to a place where there is less sunshine.
2. Lead in air	2. Wear gas mask in heavy traffic; use lead-free gasoline.
3. Smog	3. Fight temperature inversions; stop burning soot-producing fuels.
4. Carbon monoxide in air	4. Reduce carbon monoxide production in autos; reduce the animal population of the earth.
5. Sludge in sewage plants	5. Use it as a fertilizer; dump it far out in the ocean.
6. New supplies of fresh water	6. Convert salt water into fresh water; add chlorine to river water.
7. Trash and junk disposal	7. Use it to build more land; recycle the materials in it.
8. Sewage disposal	8. Build more sewage plants; run a pipeline for sewage into ocean depths.
9. Mercury in food	9. Prohibit use of mercury in manufacturing; separate mercury from factory wastes.
10. Population explosion	10. Increase food production; limit family size.

400

701

BIBLIOGRAPHY

Alexander, George. "Bugging the Bugs." National Wildlife. Volume 15, No. 5, August-September 1976.

Booth, Gary M. "Using Model Ecosystems to Predict the Environmental Behavior of Pesticides." The American Biology Teacher. Volume 39, May 1977.

Conservation News. National Wildlife Federation. Volume 41, No. 11, June 1, 1976.

"Environmental Pollution." Reprinted from the World Book Encyclopedia. Field Enterprises Educational Corp., Merchandise Mart Plaza, Chicago, Illinois, 1972.

Hill, Gladwin. Our Troubled Waters: The fight Against Water Pollution. Public Affairs Pamphlet No. 462, The Public Affairs Committee, Inc., 381 Parke Avenue, South, New York 10016, 1971.

Johnny Horizon Program. "Keeping the Bad Bugs Out. . .Naturally." Information Sheet 8, Washington, D. C. 20240.

Lead Poisoning. Englewood, California: Project 723, EPC, Inc., 1972.

"Man Against Pests" (filmstrip slide set). The slide set may be purchased from the Photography Division, Office of Information, U. S. Department of Agriculture, cost \$8.00. The record is available from this source for an additional \$1.00.

National Industrial Pollution Control Council. U. S. Department of Commerce, Mercury. Washington, D. C.: U. S. Government Printing Office, 1970.

National Wildlife. Volume 9, No. 5, August-September 1971.

"Our Struggle Against Pests." U.S.D.A., Office of Information, page 772.

Pavoni, Joseph L., et al. Preserving Man's Environment. Louisville, Kentucky: Data Courier, Inc., 1974.

Pesticides. Education Servicing Section. National Wildlife Federation, 1412 16th St., N. W., Washington, D. C. 20036.

Ranger Rick's Nature Magazine. National Wildlife Federation, Washington, D. C.

Renn, Charles E. Our Environmental Battles. LaMotte Chemical Products Co., Chestertown, Maryland 21620. March 1969.

Resource Recovery Education Program. National Association of Secondary School Principals, 1904 Association Drive, Reston, Virginia 22091.

Speight, Carol. "The No-Poison, No-Pest Garden." South Carolina Wildlife. July-August 1975

Stapp, William B., and Dorothy A. Cox. Environmental Educational Activities Manual. Junior High Activities, Stapp & Cox, 1974.

Stone, John Cary. Pesticides and Your Environment. National Wildlife Federation, Washington, D. C., 1972.

The American Biology Teacher. Volume 38, No. 4, April 1976.

Films below can be obtained from:

Film Library

S. C. Department of Health and Environmental Control

2600 Bull Street

Columbia, S. C. 29201

1. "The Gifts," Color -- Adult -- 29 minutes -- free
A film about water and air pollution which points out various sources of contamination and stresses the fact that pollution is everyone's problem. Narrated by Lorne Green.
2. "Perspectives on Pesticides" -- Adult -- 20 minutes -- free
This film can make the public aware of the danger of using pesticides without all the safety precautions with them.

SOLID WASTES

"A pile of trash is like a mine. It contains raw materials which man can use."

Overview

Today, American cities spend millions of dollars to rid themselves of human wastes and wastes derived from homes, schools, and businesses. Because matter of the earth is finite in amount and can be repeatedly cycled, every waste is an unused resource. Much of the daily discards from homes, schools, and businesses can be recovered, while metals and minerals discarded can be substituted for virgin resources in the manufacturing process. Waste CAN BE UTILIZED as an economical and ecologically desirable fuel, especially in urban areas where demands are the highest.

In the United States, solid waste generated in living units alone amounts to an average of two to more than five pounds of solid waste per person per day. Much of this waste accumulates to such an extent that it becomes harmful and is then referred to as pollutants.

The most common kinds of solid wastes are: sewage, garbage (containers, plastic, glass, metal and paper), junk (worn out appliances and furniture), and used cars.

Sewage is composed principally of biological wastes, soaps and detergents from washing. Problems associated with sewage disposal include:

- a. The spread of disease-causing organisms.
- b. High organic content of sewage encourages the growth of decomposers which use up dissolved oxygen in water.

In cities, many tons of garbage must be removed every day. Therefore, where to put garbage and other solid wastes is a major problem. Until adequate recycling is implemented, land areas must be provided for solid waste disposal. Solid wastes are probably the most visible forms of pollution. Much of the billions of tons of waste material thrown away ends up littering roadsides, floating in streams and lakes, and collecting in ugly dumps.

Solid wastes present a serious problem because most of the methods used to dispose of them result in damage to the environment. Wastes put in open dumps ruin the attractiveness of the surroundings, and land for dumps is rapidly running out. Dumps provide homes for disease--carrying animals such as cockroaches and rats--and are generally unsanitary. Burning solid wastes produces smoke that causes air pollution, and dumped solid wastes contribute to various forms of water pollution.

As human population increases and our standards of living rise, more and more wastes are being produced. We, therefore, have a great CHALLENGE: WEALTH IN WASTES! Our nation's solid wastes are vast resources of materials and energy. Fortunately, we have the technology to recover most of these resources; however, the future demands that we implement these techniques in a comprehensive recycling program.

CONTENT

Disposal of solid wastes is a growing problem.

Much waste can and should be recycled in an economically profitable manner.

710

STUDENT OBJECTIVES

The student will be able to:

Recognize the accumulation of solid wastes as a problem.

Identify types and sources of solid wastes.

Explain that solid wastes are a valuable resource.

Recognize means of recycling wastes.

369

STUDENT ACTIVITIES

Film: The Garbage Explosion, 16 minutes, color by Encyclopedia Britannica Education Corporation.

Make a collage from pictures depicting solid wastes and their sources.

Write these topics on the board: garbage, rubbish, junk. Have class list examples and sources of each under the proper heading. (Worksheet p. 378.)

Post "Wall Chart" on resource and recovery.

Plan and carry out a field trip to local recycling plant.

Have each student purchase an item of food or drink in a container. He is to eat the food and recycle (reuse) the container, or report the research findings on the recycling of his selected container.

RESOURCES

Film from Instructional Services Center, Audio-visuals Services, University of South Carolina, South Carolina.

Old magazines, books, paper, scissors, glue.

Wall Chart on Resource and Recovery. Worth from Waste. NASSP. National Center for Resource and Recovery, Inc., 1974.

Food container with food, material and equipment for recycling (depends on method of recycling).

711

CONTENT

STUDENT OBJECTIVES

STUDENT ACTIVITIES

RESOURCES

The student will be able to:

Energy in the form of heat is liberated during the combustion of some solid waste.

Certain types of solid wastes can be used to replace essential materials in the soil.

Demonstrate differences in amounts of heat liberated by combustion of different solid waste samples.

Describe the effects of decaying garbage on the soil.

Recycle Glass: Obtain powdered glass by enclosing pieces of broken glass in a heavy cloth. Carefully shatter the glass into small peices with a hammer. Transfer the pieces of glass to a mortar and grind into a powder using a pestle.

Place about one gram of powdered glass into a crucible.

Heat the crucible at maximum heat of a Bunsen burner.

After ten minutes, observe clear glass that has formed at the bottom of the crucible.

Heat energy from waste material. Experiment p. 379.

Build a compost heap (at home or school). Include vegetation such as leaves, lawn clippings, hedge clippings, and other organic wastes. This can eventually be spread as fertilizer--natural recycling of garbage.

Build a composting machine

Broken pieces of glass, heavy cloth, hammer, mortar and pestle, crucible, scale, Bunsen burner.

"Barrel Composter." Organic Gardening and Farming, June 1978, p. 58.

CONTENT

Paper can be recycled into a lower grade of paper.

There are different methods of treating solid wastes: burning, landfills, incineration, compacting and shredding, recycling, composting.

Some are damaging to the environment, hazardous to health, and illegal in certain locations.

STUDENT OBJECTIVES

The student will be able to:

Demonstrate a simple method of paper recycling.

Explain how trash and garbage are handled after being hauled away.

Explain the cost and manpower necessary in disposal of solid wastes.

STUDENT ACTIVITIES

Use animal wastes as organic fertilizers.

Recycle paper. Experiment P. 379.

Investigate the method used in your community for collecting, transporting and disposing of solid wastes. Check both private and municipal agencies. Record your findings.

Prepare a report on the comparative advantages of new systems of collection and disposal of solid wastes. Study: costs, labor and equipment.

Research and report on recent developments in reducing the problems and costs of solid waste disposal.

What is the estimated expense to local governments (taxpayers) to process and landfill solid waste?

Relate today's amount of wastes and cost of disposal to that projected for 1985.

RESOURCES

CONTENT

STUDENT OBJECTIVES

The student will be able to:

List ways that waste disposal pollutes the environment.

STUDENT ACTIVITIES

Demonstrate the air pollution created by open burning or improper incineration.

- a. Place moth flakes into porcelain spoon. Observe the whiteness of the material.
- b. Burn the material in the flame of the Bunsen burner.
- c. Note the large quantity of soot that is formed.

Construct a model landfill showing how water pollution may result. Experiment P. 380.

Mock "Municiple Dump"

- a. Establish a classroom rule that the wastebasket will not be used for one week. (Be careful about pests that you may encounter.)
- b. Pile the trash in a corner instead of a wastebasket.
- c. Discuss results - problems involved, pollution, space occupied, hazards, etc.
- d. What methods would you suggest for disposal of your "municipal dump?" Include recycling in your plans.
- e. Is there a recycling plant or organization in your community? If not, try to start one.

RESOURCES

Moth flakes, porcelain spoon, Bunsen burner. Styrofoam or aspirin may be used instead of moth flakes.

S.C. Wildlife, November-December 1976, P. 17.

CONTENT

Solid wastes originate from human activities and are proportional to current populations and life styles. More people create more waste.

718

STUDENT OBJECTIVES

The student will be able to:

Explain the relationship between accumulated solid waste and increase in human population in his community.

Recognize that human life-styles relate to problems of solid waste.

373

STUDENT ACTIVITIES

Library research. Look for and record:

- a. Average number of pounds of cartons, paper wrappings, plastic bottles, cans and other containers--all packaging material consumed by Americans in one year.
- b. List the specific lifestyles that account for an increase in modern packaging.
- c. How does family structure relate to the problem?
- d. Optional: Prepare a bulletin board display relating human activity and lifestyle to increased solid wastes.

Take a sketching trip through your school and through a significantly larger or smaller school.

Record aspects of solid waste control, neglect and littering. Discuss sketches and make individual posters suggesting ways of improvement in specific areas.

RESOURCES

719

CONTENT

Solid wastes are broken down in different ways:

Biological (microbes)
Chemical
Physical

STUDENT OBJECTIVES

The student will be able to:

Explain the rate of breakdown of selected kinds of solid wastes.

STUDENT ACTIVITIES

Construct a model Sanitary Landfill to show which materials decompose most readily, which will not decompose, which settle readily, etc.

Place waste materials along sides of jar so they are easily visible.

Fill the jar with dirt.
Replace the lid.

Label all materials from the outside of the jar. This represents a sanitary landfill.

Set your project aside and observe at intervals over a period of three or more months.

Record observations as follows:

Materials	Months	Changes	Obser.
Glass			
Wood			
Rubber			
Steel			

RESOURCES

720

721

CONTENT

Individual decisions regarding management of solid waste materials are influenced by economics, technology, and public concerns: You Can Help!

722

STUDENT OBJECTIVES

The student will be able to:

Discuss the importance of consumer action and individual responsibility in solid waste management programs.

375

STUDENT ACTIVITIES

Investigate and report to class:

What are the laws governing trash disposal in your community?

How is your state trying to solve the problems?

What new laws are being considered by state legislators? (Bottle Bill)

Are there any oppositions? Why?

Find out what the Environmental Protection Agency has done and what it is planning to do concerning solid waste.

Make posters for your school and community to encourage:

Participation in legislation that governs solid waste disposal.

Limitation of waste and careful use of household products.

Organic gardening and recycling.

RESOURCES

723

CONTENT

STUDENT OBJECTIVES

The student will be able to:

STUDENT ACTIVITIES

RESOURCES

Ask community groups and school clubs to plan and implement ways to solve the litter problems.

Plan and implement a clean-up campaign in your community.

Participate in poster contest, sticker handouts, etc. Create and produce spot announcements and get local radio stations to use them.

Solid Wastes

Bibliography

- Andrews, William A., Environmental Pollution, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1972.
- Badgley, Debbie, Solid Waste, (a transparency program), Environmental Education Center, Oteen, N.C., February 1973.
- Dasmann, Raymond F., et. al., As We Live and Breathe, The National Geographic Society, 1971.
- Office of Conservation Education, Federal Energy Administration, Washington, D.C. 20461, Energy Conservation Now.
- Thomas A. Edison Foundation, Inc., 2000 Second Avenue, Detroit, Michigan 48226, 1973, Environmental Experiments--from Edison.
- National Industrial Pollution Control Council, Washington, D.C., 1971, Glass Containers (Sub-Council Report).
- Pavoni, Joseph L., Joseph Hagerty, John E. Heer, Preserving Man's Environment, Data Courier, Inc., Louisville, Kentucky, 1974.
- S.C. Department of Education, 1006 Rutledge Building, Columbia, S.C. 29201, Resources for Environmental Education.
- Resources for the Future, 1755 Massachusetts Avenue, NW, Washington, D.C. 20036, Resources, No. 54.
- Glass Container Manufacturers Institute, Inc., Committee on Public Affairs, New York, Solid Waste Fact Book.
- National Wildlife Federation, "Ideas for Teachers," Wildlife Week, 1977.

NAME _____

GARBAGE

JUNK

RUBBISH

Examples	Source	Examples	Source	Examples	Source

728

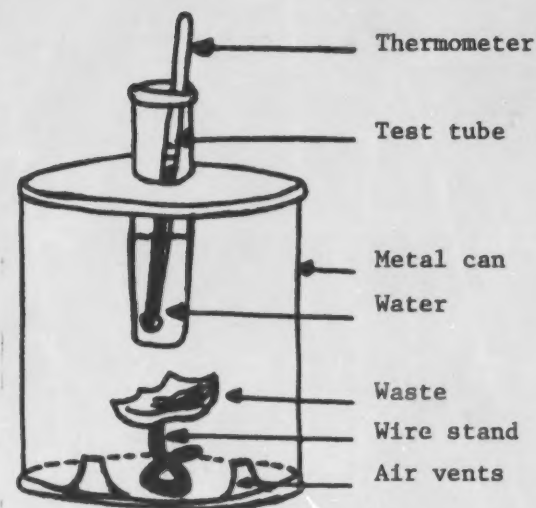
723

EXPERIMENTS

Heat Energy From Waste Materials

Materials: Calorimeter or tin can, small test tube, wire, thermometer, waste-paper, matches, scales, water, etc.

Procedure: Construct a calorimeter by placing a small test tube in a metal can with large cuts at the bottom and air vents (small holes) in the top. Construct from wire a stand on which waste material can be mounted. Place thermometer in test tube. Add three ml. of water to test tube, record temperature and remove thermometer. Mount 0.5 gram of waste (paper) on wire stand so that the flame almost contacts test tube. Ignite the paper and allow to burn. As soon as burning is completed, measure and record the temperature of the water. Repeat the procedure, using some other waste that will ignite from the flame of a match. Compare temperature changes for the different kinds of wastes. Note that observations are relative since heat will be lost from your crude calorimeter.



Recycle Paper

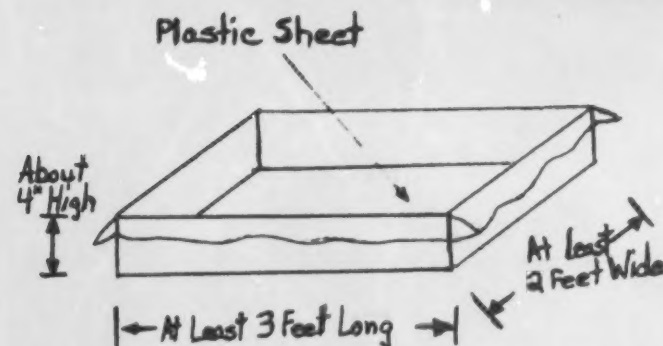
Materials: Newspaper, mixing bowl, electric mixer or egg beater, tablespoon of wallpaper paste or laundry starch, section of window screen, cake pan, wax paper, drinking glass per jar.

Procedure: Cut paper into small (12" x 12") pieces. Place pieces of paper into the mixing bowl, add a cup of water, let paper soak for a little while. Churn or mix the paper and water with the beater or mixer. Continue until the mixture looks like rolled oats cereal. Mix paper mixture with wallpaper paste (1 tablespoon dissolved in a little water) or liquid starch. Hold the screen over the cake pan, pour starch-paper mixture over screen. Spread the mixture out like a thin pancake. Lay a sheet of wax paper over the mixture and roll a jar over it to squeeze out water. Allow the mixture to dry two days or more. When dry, peel paper from screen. It will look and feel like gray cardboard.

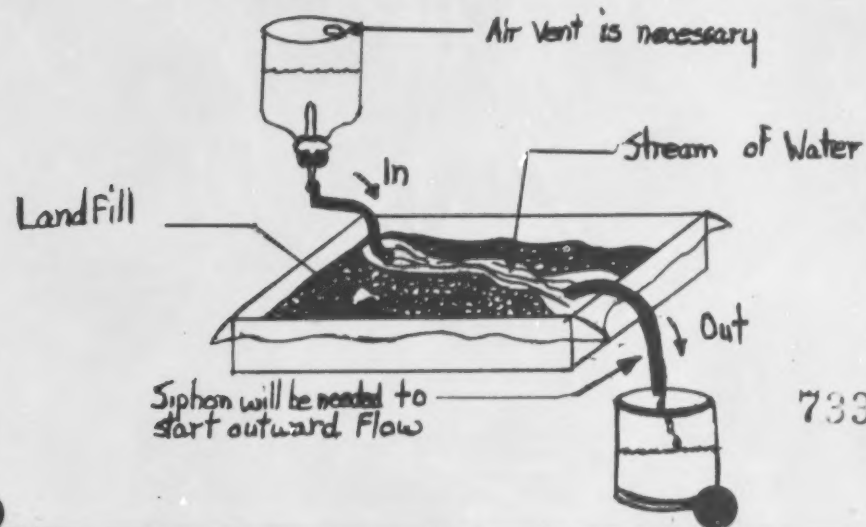
Construct a Model Landfill Showing How Water Pollution May Result

Materials: Tray or box, plastic, sand or dirt, crystals of potassium permanganate (KMnO_4).

- Procedure:**
- Cover the sides and bottom of the box with plastic.
 - Add sand. Establish a grade by having the sand three inches on its highest end and one inch on the lowest.
 - Dig out a channel from the higher elevation to the lower to form a channel. Use continuously running water through the channel as shown to simulate a stream.



- c. Dig out a channel from the higher elevation to the lower to form a channel. Use continuously running water through the channel as shown to simulate a stream.



POLLUTION

Developed by:
Nova High School
Broward Co., Florida
ESEA Title III Project

	1		2	3	4			5	6		7	8	9		10
11		12						13			14			15	
16							17			18		19			
20							21						22		
		23					24					25			26
27	28					29			30					31	
32		33			34				35		36		37		
38							39	40		41					42
	43		44	45		46			47				48	49	
50					51			52		53	54			55	
		56					57						58		
59	60			61	62	63					64	65			
66			67					68		69				70	
71					72		73			74					75
76			77							78					

ACROSS

2. Beverage (suffix).
5. Formula of poisonous exhaust gas polluting the air.
7. _____ sewage is polluting our canals.
11. _____ from cans is being dumped in vacant lots.
13. Abbreviation for recto.
14. Rubbish or _____ litters our streets.
16. Exposing to air.
17. Smoke in the air impeding vision.
19. We must _____ all of our resources to control pollution.
20. Septic tank _____ is being dumped into the Gulf Stream.
21. Pollution is so extensive that _____ if we start a vigorous campaign it may be too late.
22. Abbreviation for title page.
23. The water level in the Everglades has posed a great problem to the _____.
24. Abbreviation for Alcoholics Anonymous.
25. Airplanes that contribute greatly to air pollution.
27. Each of us should do _____ much as possible to prevent pollution.
29. Pollution will change or _____ our environment.
31. Pollution _____ one of man's greatest problems.
32. Los Angeles is famous for its _____, (air pollution)
34. An insecticide that is polluting the soil and our food.
35. An imaginary line showing no magnetic declination.
38. South African hill or mountain.
39. Abbreviation for hour.
41. Pollution is like a _____ around our necks.
43. It is up to us to _____ our campus clean.
46. Organs of sight that are being polluted.
48. General formula for ethers.
50. We can do a _____ to ourselves and future generations by combating pollution.
52. Vaporous smoke polluting the air.
55. Abbreviation for Industrial Engineer.
56. Concerned with radioactive pollution.
57. Places where rubbish is unloaded.
58. Abbreviation for Algebra.
59. We need to use all of our intellectual power or _____ to combat pollution.

Across Con't.

61. Extensive water pollution _____ fish.
64. Exhaust fumes from the _____ contain carbon monoxide. (auto)
66. Nearly all _____ of the United States have serious pollution problems.
68. Autos empty out their gaseous waste through the _____ pipe.
71. To pant for breath.
72. Distress signal.
74. The science dealing with light.
76. In. (prefix)
77. Ships that have been polluting Florida beaches with oil.
78. Greek Goddess of Dawn.

DOWN

1. We will certainly _____ future generations if we do not control pollution now.
2. We cannot tolerate or _____ pollution.
3. Everyone should be aware of the _____ of pollution.
4. A type of moth.
5. A necktie.
6. The slime in a river bed.
7. Abbreviation for right.
8. American Rubbish Unlimited. (abbreviation)
9. Refuse and/or rubbish.
10. Exclamation of regret.
11. Needed to filter poisonous gases from the air.
12. Refuse and Rubbish Under Discussion. (abbreviation)
15. Most homes in Broward County have _____ tanks.
17. Pollution is not _____. (concerning our well being)
18. We must exert all of our _____ to control pollution.
25. Hollywood has placed a \$100 fine on littering the streets with old _____.
26. Abbreviation for steamship. (they do their share of polluting)
28. Billows from the stacks at Port Everglades.
29. An advertisement.
30. _____ of us must do his share to control pollution. (abbreviation)
33. You can certainly determine when the electric generator plant _____.
34. Everyone must _____ his best to control pollution.

Down Con't.

- 36. Combining form meaning "egg."
- 37. Noun suffix equivalent to "eer."
- 40. Rubbish or waste.
- 42. Corrupt matter in liquids (residue).
- 44. First woman to pollute the earth.
- 45. The garbage man _____ up trash.
- 46. Electrical Engineer. (abbreviation)
- 47. Total.
- 49. _____ from tankers has polluted Florida beaches.
- 50. Content of a sewer.
- 53. Modern pollution. (abbreviation)
- 54. The inhabitants of the earth cannot _____ pollution. (avoid)
- 57. Deciliter. (abbreviation)
- 58. The unaccented part of a measure in music.
- 60. Persia.
- 63. To see.
- 65. Automobile.
- 67. Likely.
- 69. A cry of delight.
- 70. Chemical symbol for technetium. (element 43)
- 72. Chemical symbol for tin.
- 73. Sanitary Engineer. (abbreviation)
- 75. Chemical symbol for strontium.

SOUNDS OF NOISE

Sounds are all around us. there are the sounds of silence; the sounds of our own body; the sounds of earth, air, sea, and the living things that inhabit it... and then there are the sounds of civilization. Sounds can take the listener out of his environment to the lands of his fantasy. The urbanite can visit the ocean, forest or farm through sounds organized in a "mental transportation." The listener blends sounds into pictures with his own imagination. He interpretes each sound by experience and the circumstances surrounding that sound. A loud sound will appear louder or softer, depending on the sounds that preceded it or follow it. A quiet sound gains in intensity by the degree of loudness surrounding it. Sound permits communication between people, it makes possible the enjoyment of music and nature. It is so vital for life-saving warnings. Some sounds are called music.

"There's music in the sighing of a reed;
There's music in the gushing of a rill;
There's music in all things, if man had ears;
The earth is but the music of the spheres."

George Gordon, Lord Byron.

And then there are the SOUNDS OF NOISE. What is noise? The sound of your voice may be music to my ear or it may be noise. Noise is in the mind of the interpreter... it can be an unwanted or disagreeable sound, it can be unorganized or discordant sound or it can simply be interference with the desired sounds being transmitted. Sound becomes noise when the acoustic energy causes undue stress and actual physiological damage, when it damages the hearing mechanism, causes detrimental bodily effects, disturbs sleep and rest, or annoys or irritates. Frequently noise is harmfully loud sound, whether wanted or unwanted. In the home noisy air conditioners, refrigerators, stove exhausts, other appliances, and traffic produce continuous masking that

necessitates increasing the volume of voices, radio and television. These appliances making noises, that you have "tuned out", can still cause harmful effects to health and hearing.

Recent studies indicate that people tend to organize the sounds around them so that they are not disruptive to their existence... in this respect they can be structured to form music. Music has been defined as a picture of sound on a background of silence. It is structured with pattern and form. As primitive man used objects and sounds that were natural to his environment, modern man uses the sounds of civilization and his environment to organize musical compositions. But are these "contemporary" sounds harmful to health? Are they really a form of pollution?

Studies in the early '70's indicated that noise adversely affects at least 40% of the population of the U.S. Industrial noise alone costs more than \$4 billion a year in absenteeism, inefficiency, accidents, and health claims. At least half of American industry permits noise levels above the 90 dbA level. Workers who run a high risk of temporary and permanent hearing loss include boilermakers; weavers; bulldozer and jackhammer operators; drivers of taxies, buses, and trucks; mechanics; shop foremen; rock band performers; and riveters.

Machines do not have to be noisy. Other countries are far ahead of us in the control of noise. Some have developed quiet jackhammers, pile drivers, and other machines; have rubberized garbage trucks; put noise control standards on cars, motorcycles, trucks, airplanes, home appliances and factories. Quiet garbage cans, vacuum cleaners, and office machines are available. Noise control provisions could be written into building codes, required for appliances, equipment and vehicle manufacturing, and placed on construction standards.

There is growing concern and some action has been taken by federal, state and city officials to enact laws to set noise level standards. Do you have any in your town? state? are any planned?

CONTENT

There are 3 aspects of sound:

- (1) a source - sounds are produced by vibrating objects;
- (2) a transmitting media or substance - sound can not travel through a vacuum, but must have a substance;
- (3) a receptor - hearing and body responses.

Some substances conduct sound more easily than others. Some act as insulators. Temperature can also affect sounds.

Sound is characterized by amplitude, wave-length, frequency (pitch) and speed. These vary with different media. Frequencies above hearing range are called ultrasonic.

STUDENT OBJECTIVES

The student will be able to:

Describe the three aspects of sound.

Identify materials that are good conductors and those that are insulators.

Describe the main characteristics of sound.

Identify some modern uses of ultrasonic sound.

STUDENT ACTIVITIES

Place a vibrating tuning fork against a book, desk, metal, cloth, wall, floor. What kind of material carries sound best? What kinds of materials increase sound? decrease sound?

Design an experiment to find a good insulator of sound. (ex. place the microphone of a tape recorder under different substances and speak the same thing at the same volume for each substance. Play the recording to determine the best insulator.

Demonstrate wave-length, frequency and amplitude with a "slinky."

RESOURCES

Tuning fork.

Tape recorder with microphone.

Slinky.

CONTENT

Loudness or volume is measured in units called decibels which are on a dimensionless scale of values (unlike inches or pounds - 0 is not the absence of sound but the lowest audible sound for a healthy young human ear). Decibels progress logarithmically not arithmetically. Therefore, each change of decibel level represents a sizable change in acoustic energy.

Sound results from a vibrating object and can cause other objects to vibrate. This energy can cause great impact and can be used to break rock, mix paint, or wash dishes.

STUDENT OBJECTIVES

The student will be able to:

Use a decibel meter to measure sound volume.

Demonstrate the impact of sound on objects.

STUDENT ACTIVITIES

Borrow a decibel meter and check noise levels in each room of your house. Check with stereo or TV on and off, in the same room with the stereo and in other rooms.

Check noise level of your car, lawn mower and other household appliances. Make a list of those which are loud enough to be harmful.

Identify and demonstrate to the class sources of high-pitched and low-pitched sounds. Generalize what kinds of things make low or high-pitched sound.

Demonstrate pitch with a series of glasses of the same size with different amounts of water in each.

Using a tuning fork, strike it to make a sound then put the handle into a pan of water. Describe and explain what results.

List illustrations of the power of sound - ex. singer shatter glass, pipe organ rattle the windows, etc.

RESOURCES

Decibel meter.

Set of glasses containing water.

Tuning fork and a pan of water.

745

746

CONTENT

Sound vibrations are collected by the ear and are transmitted by nerves to the brain where they are interpreted.

The ear has three main parts designed for transmission of sound:

- (1) outer ear - gathers sound waves which cause the ear drum to vibrate.
- (2) middle ear - transmits vibrations and amplifies weak waves.
- (3) inner ear - transmit vibrations through the fluid-filled cochlea where they stimulate nerve ends. The inner ear is also capable of receiving acoustic energy by way of bone and tissue conduction.

Intense sound waves can penetrate skull and torso. The human body is so sensitive to sound that even the description of unpleasant sound can cause a physical response (ex. chalk on blackboard).

747

STUDENT OBJECTIVES

The student will be able to:

Draw and describe the parts of the hearing mechanism and explain its function.

STUDENT ACTIVITIES

Find materials in your environment to construct a model that demonstrates the functions of the ear. Construct the model.

Make a survey of at least 50 students not in your class to determine how much they know about the hearing process. Carefully construct your questionnaire before you begin.

Do some research and report on the latest treatments developed to assist people with hearing problems. (Include a discussion of charlatans selling hearing aids.)

Place a vibrating tuning fork to forehead, chest, leg. Describe what happens. Describe your body's response to vibrations.

RESOURCES

748

CONTENT

The auditory nerve carries messages to the brain where they are interpreted.

The brain transmits resultant impulses to almost every nerve center and organ in the body.

As a result, sound may produce physiological and/or psychological effects. These include:

- hearing loss
- nausea
- rise in the blood pressure
- stress
- muscle tenseness
- change in blood vessel diameter
- anxiety
- insomnia
- behavior changes.

Physiological damage can occur even though psychological ones have been submerged. Responses continue even though the person believes he is accustomed to the sounds.

STUDENT OBJECTIVES

The student will be able to:

Explain the transmission of sound to other parts of the body.

List and describe some of the physiological and psychological effects of sound.

Identify sounds that have been "tuned out."

STUDENT ACTIVITIES

Make a recording of various sounds - car, telephone, doorbell, alarm clock, piano, air conditioner, dripping faucet, rock music, dog barking, bird song, blender. Play the sounds for the class and ask them to group them as to:

- pleasant - unpleasant
- noisy - quiet
- harmful - helpful
- happy - sad

Go outside with a tape recorder and find and bring back sounds of morning, day and night. Are the sounds at dawn or dusk different than sounds later in the day - explain. How does the sound make you feel? Do the same sounds create the same feelings in everyone?

Discuss and react to: Dr. E. F. Crippen, Deputy Health Commissioner of Detroit, while investigating the city's 1967 riots suggested that tension in the ghettos may be attributable to interrupted sleep. "The din of the modern city," he said, "includes noises far above levels for optimum sleeping. Result: insomnia and instability."

RESOURCES

Tape recorder.

Tape recorder.

CONTENT

Acclimatization to noise can create a dependence on noise. The most dangerous noise is that to which we are accustomed that we no longer hear, such as: household appliances, traffic, etc. These noises cause physiological responses even though we don't "hear" them. Noise can cause deafness - the cumulative effect of prolonged exposure to noise, even that below the levels produced by average city traffic.

The excessive acoustic stimuli to which modern man is subjected, abuses his sense of hearing so that medical men speak of 2 phases of "ear life": the length of time the ear will serve us for hearing a wide range of sounds, and the length of time the ear will serve us for hearing speech.

After the brain receives the sound signal, it places the body on a war footing. The repetition of these alerts is exhausting and depletes energy.

751

STUDENT OBJECTIVES

The student will be able to:

Demonstrate greater awareness of sounds in their environment.

Describe the effect of repeated alerts and intermittent sounds on people.

391

STUDENT ACTIVITIES

Using a tape recorder, make recording on a field trip or while going to or from school. Record all the sounds you hear in a notebook, then play the tape and determine which sounds you did not hear.

Do a noise sensitivity survey. Make a tape recording of 20 sounds - each separate and distinct from the others. Precede each sound with an identification number. (ex. people shouting, washing machine, blender, car motor, etc.) Make a rating scale of 1-5 (1 - very quiet, 5 - very noisy). Play the recording for the same number of boys and girls... the more the better. See which, boys or girls, are more sensitive to noise.

List instances when you have been warned or alerted to danger by sound.

RESOURCES

Tape recorder.

752

CONTENT

Hearing loss occurs first in higher frequency. It depends on overall noise level, frequency of noise, duration and time distribution of noise exposure.

Signs of too much noise exposure include: tendency to shout, hearing muffled sounds, ringing in ears.

Amplified music has developed into a threat to hearing. Amplified instruments have produced levels of from 90 to 105 decibels. These are especially hazardous.

Major sources of noise include household appliances, transportation, industrialization and an increased concentration of people.

Noise levels can be reduced by sound insulators, architectural and landscape planning and elimination of unnecessary noise.

STUDENT OBJECTIVES

The student will be able to:

List the causes of hearing loss.

Identify ways to protect himself from noise damage.

Identify sources of noise in the environment.

Describe ways of reducing noise levels.

STUDENT ACTIVITIES

List precautions for averting hearing damage. Make a display of safety equipment for human ears.

Invite a school nurse to come and explain the audiometer. Perhaps she will check the hearing ability of students in the class.

There are composers who hold that noises have a definite and important place in music; that there is music in noise; that noise is as basic to contemporary music as it is to contemporary life. Do you agree or disagree? Discuss.

Using a decibel meter determine the noise level of each appliance in your house. List them in order from quietest to noisiest. How many of these appliances were used 10 years ago? Can you conclude that your home is getting noisier or quieter?

RESOURCES

Decibel meter.

CONTENT

Proper attitudes and the recognition of individual responsibility are prerequisites for adequate management of unwanted sound.

Management of sound involves maintaining a balance in the use of sound for necessary purposes such as sirens, unavoidable construction noise, control of harmful or disagreeable sound.

Anti-noise legislation can be enacted, but effective implementation depends on willingness of people to accept the costs and make changes at home.

Concerned citizens can become involved in issues that pose a particular threat to health - ex. airports, rock music, etc.

STUDENT OBJECTIVES

The student will be able to:

List things that he can do to reduce the noise level at home and at school.

List unavoidable and necessary sounds, and compare them to harmful and unnecessary sounds in his environment.

Explain any local, state or federal noise ordinances.

Describe possible legislation for noise control.

Explain proper procedures for reporting noise violations.

List agencies involved in noise control.

Describe rules to prevent hearing loss.

STUDENT ACTIVITIES

Tour the school property with a landscape architect to determine what type of tree and shrub planting would produce a quieter classroom atmosphere.

Interview people living near an interstate to obtain their views about traffic noise.

Arrange a meeting with city officials to find out if there are any noise regulations in your area.

Debate the law requiring helmets on motorcyclists. Do they or do they not inhibit hearing? How could you test this?

Cut out the activity cards and mount them on sturdy card material. They may then be laminated and given to the students for additional individualized activities.

Make a Noise graph (ex. p. 396-397.)

RESOURCES

Activity cards
(p. 398 and 399).

Graph (p. 396-397)

CONTENT

STUDENT OBJECTIVES

STUDENT ACTIVITIES

RESOURCES

If you live near an airport, find out what is being done to reduce noise levels. Invite a representative to come to class and explain supersonic boom, and what is being done to minimize this kind of noise.

Organize and conduct a debate on whether the Concord should be allowed to land in this country.

Confer with local industry's safety director and ask about noise level and safety measures.

Discuss the present trend to smaller cars and difference in noise in a small car vs. a large one. In light of the energy shortage, how could small cars be made less noisy without greatly decreasing the gas mileage?

Visit an automobile dealer and find out what has been added to reduce noise.

Special Project: This is an evaluation of a site's exposure to roadway noise. It includes graphs and data to assist with the project.

"High School Noise." Environmental Exchange, a beginning. President's Environmental Merit Awards Program, U.S. Environmental Protection Agency, Washington, D.C., 20460, 1974.

ADDITIONAL ACTIVITIES

Interview an architect to find out what steps are taken to reduce echoes in classrooms and auditoriums. Tour your school building to see which of these techniques were used.

Conduct a downtown survey to find out "What do you consider the worst noise problem in your town?"

Prepare a report on one of the following:

- International airports and noise

- Materials used to deaden sound

- Transportation noise

- Industry - protective measures from noise.

Make a map of your city's noise.

You may do this riding all bus routes with a decibel meter and an understanding bus driver.

Record location and time of day and plot results on a city map.

Using a tape recorder, record many different "house" sounds or natural sounds or school sounds. Make a musical composition with your sounds.

Visit an automobile tire store and find out what makes tires noisy. What kind of tires are quietest?

Visit the town or area planning office to find out which streets are restricted for use by trucks and other commercial vehicles. If no ordinances exist, write a sample and determine the proper procedure for getting it enacted.

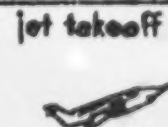
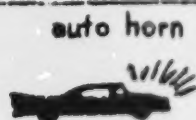
Report on the construction of the bandroom in your school, noting all steps, including location, which have been taken to sound proof it.

Make a poster or have a poster contest to warn people about the dangers of noise.

decibels

220
200
180
160
140
120
100
80
60
40
20
0

NOISE LEVELS



Estimate the loudness (in decibels) of each of the sounds shown above.

REFERENCE MATERIAL

DECIBEL	SOURCE	EFFECT
0	breathing, rustling leaves	threshold of hearing
10	rustling leaves, whisper	just audible
20	whisper, studio for sound pictures	very faint
30	library, whisper at 5 ft., watch ticking, bedroom	faint - very quiet
40	living room, normal conversation,	
50	quiet home, quiet street, or office	quiet - moderate
60	refrigerator, suburb, conversation in a restaurant,	
	large office, clothes dryer, washer, exhaust fan,	
	radio, clock, dishwasher, toilet flushing, playground	
70	Air conditioning, freeway traffic, vacuum cleaner at 10 ft.	intrusive - loud - telephone use difficult
	can opener, hair dryer, garbage disposal, mixer	
80	Inside car at 50 mph, truck, muffled snowmobile,	annoying
	garbage collecting, baby crying, vacuum cleaner,	
	inside subway	
90	Heavy truck, farm tractor, motorcycle, food blender,	HEARING DAMAGE (8 hrs.), very annoying,
	screaming child, inside jet at takeoff, power lawn mower,	work efficiency decreases, errors increase
	inside subway station	
100	Inside DC-6, shout at .5ft., outside a jet at takeoff,	SERIOUS HEARING DAMAGE - deafening
	(1000 ft.) working near helicopter	
110	Riveting-machine, motorcycle (25 ft.), auto horn (3 ft.),	Ear discomfort, maximum vocal effort
	circular saw, rock band, house party, jet airport	
120	Jet takeoff (200 ft.) auto horn, siren, riveting on steel	Human pain threshold - physical damage
	plates, thunderclap	
130	Jet plane (50 ft.), shotgun blast, siren	limit amplified speech
140	Carrier deck jet operation, hydraulic press (3 ft.)	painfully loud, EARDRUM MAY RUPTURE
150	Rocket engine - jet takeoff	ringing sensation in ear EARDRUM RUPTURES
160	Electric shovel drill	

Go outside and sit in a quiet place and listen to soft natural sounds. After a few minutes say your name out loud five times. Decide whether the human voice is noise or music and why.

Go outside and find objects in your environment that have names that do not sound like what they are or mean. Invent a new word to identify your objects.

MORE: Place all objects and new words on a table. Have friends see if they can match the invented word with the correct object.

Choose a word that sounds like its meaning. Try saying it in a variety of ways until you discover a way of saying it that makes it sound more like its meaning.

Go outside and tape sounds (natural and/or man made). Put them together in such a way as to produce a composition.

Choose a single word and write a composition for two or more voices

Go outside and find objects in your environment that would not ordinarily be considered musical instruments but can be made to produce sound. Produce a composition of sounds you obtain from your objects.

MORE: You may give the instruments to your classmates and conduct an orchestra.

Go outside and listen to sounds for five minutes. Write down what you hear and describe how they make you feel.

Place a snare drum near a piano and strike a chord on the piano. Does the drum vibrate? Explain.

Stand on a busy street corner in your community or by the road in front of the school. Make a list of the different sounds that you can identify. What kind of reaction do you have to each sound? How does the combination of sounds make you feel?

765

(cut along lines)

756

Make a list of predictable and unpredictable sounds around your school. Which sounds do your classmates complain about most? Why are unpredictable or irregular sounds more annoying than steady or predictable sounds?

Make a list of adjectives used to describe sounds. Arrange them from most pleasant to most annoying (ex. melodious - nerve-wracking).

List ways that you can reduce the noise level at home and at school.

Write a letter to a person in the year 1850 describing city noise today.

Walk along the beach or along a path in the woods. Imagine you are an orchestra conductor. For each sound that you hear and identify, label it as a musical instrument and justify.

Listen to a recording of an orchestra and pick out the sound of a single instrument.

Record sounds inside and then record sounds outside in the environment. Describe the difference in sounds. Where do you feel most comfortable?

Draw a room diagram illustrating the arrangement of stereo speakers with explanation of relationship to carpeting and draperies.

Obtain a pipe and a wooden stick. Ask a friend to scratch one end of the pipe while you listen. Then do the same with the stick. Which one carries sound the best?

757

758

These materials should be available from the USC - Documents Library, Columbia, S.C.

House, Public Works and Transportation Committee. Subcommittee on Aviation,
Current and proposed federal policy on the abatement of aircraft noise. Dec. 1975, Jan., Feb., Mar. 1976.
hearings. Y4.P96/11: 94-36. (Committee Serial No. 94-36)

Senate, Select Committee on Small Business. Subcommittee on Government Regulation,
Social, economic, and physiological problems caused by industrial noise; hearings. July 23-25, 1976.
500 p. y4.SM1/2:N69

House, Public Works and Transportation Committee. Subcommittee on Aviation,
Aircraft noise, hearings. Sept., 1976. 25 p. Y4.P96/11:94-64 (Focuses on HR 14027 - "Aircraft Noise Reduction and
Airport Protection Act of 1976").

Senate, Environment and Public Works Committee.
Environmental protection affairs of the 94th Congress. Feb. 1977. (Committee serial No. 95-3) pp. 337-350
contain article on noise control.

The Code must be used in the library.

Federal regulations pertaining to noise pollution:

Code of Federal Regulations -

- See Title 40, Subchapter G, "Noise Abatement Programs" Sections 201-210.
- See Title 29, Section 1910.95 - "Occupational Noise Exposure"
- See Title 49, Part 325 "Compliance with Interstate Motor Carrier Noise Emission Standards"
- See Title 41, Section 50 - 204.10 "Occupational Noise Exposure"

REFERENCES

- Allen, Rodney F. et. al. Deciding How to Live on Spaceship Earth. C. 1973. St. Mary's College Press, Winona, Minnesota, pp. 27-37.
- Baron, Robert Alex. "Noise - What it is . . . What it Does to You." Vogue, Nov. 1, 1970.
- Berland, Theodore. Noise - The Third Pollution. C. 1970. Public Affairs Committee, Inc.
- Bugliarello, George; Ariel Alexandra; John Barnes; Charles Wobstein. The Impact of Noise Pollution, A Socio-Technological Introduction. The Pergamon Press, Inc., New York. 1976.
- Kavaler, Lucy. Noise: The New Menace. The John Day Company, New York. C. 1975.
- Lipscomb, Dave M. Noise: The Unwanted Sounds. Nelson-Hall Company, Chicago. C. 1974.
- Motor Vehicle Noise Control, Special Report 152, Transportation Research Council, National Research Council, Washington, DC. 1975.
- O'Donnell, Patrick A. Noise Pollution. Addison-Wesley Publishing Company, Menlo Park, California. 1971.
- Pavini, Hagerty, Heer. Preserving Man's Environment. Data Courier, Inc., Louisville, Kentucky. C. 1974.
- Public Law 92-574, Noise Control Act, 92nd Congress, H.R. 11021, October 27, 1972.
- Stehney, Virginia A. Environmental Curiosity Sampler. "What can be done to eliminate noise?", pp. 64-65. Environmental Protection Agency, Research Triangle Park, North Carolina 27711.